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OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION.

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INSTITUTED 1832.

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J. CHURCHILL, PRINCES STREET;
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THE

RETROSPECTIVE ADDRESS,

ON THE

DETECTION AND TREATMENT OF SOME OF THE PRINCIPAL

DISEASES OF THE CHEST.

BY EDWARD JAMES SHEARMAN, M.D.,

Licentiate of the Royal College of Physicians, Rotherham.

DELIVERED AT

THE FIFTEENTH ANNIVERSARY MEETING

OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION,

HELD AT DERBY,

ON WEDNESDAY AND THURSDAY, AUGUST 4TH & 5TH, 1847.

When the writer undertook, at the request of the Council, the task of producing the Retrospective Address in Medicine to the Provincial Medical and Surgical Association for 1847, he expected to be called upon merely to arrange in their proper groups the various improvements in pathology and the practice of medicine which the medical press of the year might bring to light: he was entirely ignorant of the premeditated alteration in the nature of the Address, which was made at the last Annual Meeting, and regrets his absence at that Meeting, because he had not the opportunity of declining an honour, the difficulty of performing which, no one can feel more deeply than himself. Those Members of the Association who know the toil and anxiety connected with an extensive country practice, will sympathise with him; and he feels certain of obtaining the sympathy of his personal friends, who know his inability to read an Address, which task he has been obliged to delegate to his son. The only good quality he ventures to promise the hearers

of this Address is brevity, while he endeavours to give a Retrospective Sketch of the advances made in the Detection and Treatment of some of the principal Diseases of the Chest, with a glance at the Changes observed in the Secretions during their course.

The tissue of the lungs is made up of the ramifications of the bronchial tubes, the ramifications of the pulmonary vessels, and the air-cells, together with a bed of cellular tissue.

The bronchial tubes commence at the bifurcation of the trachea, and subdivide until their diameters are reduced from the $\frac{1}{30}$th to the $\frac{1}{50}$th of an inch; and up to this point they are lined with *mucous* membrane. The air is conveyed from this point through *intercellular passages* to the air-cells. The intercellular passages and air-cells are lined by *fibrous* membrane. The passages vary in diameter and length, but never exceed the diameter of the ultimate divisions of the bronchi. The air-cells are from $\frac{1}{200}$th to $\frac{1}{70}$th of an inch in diameter, but vary considerably, being smaller and more vascular in the middle, and larger and less vascular at the remoter parts of the lung.

The bronchial arteries supply nourishment to the tissue of the lungs, ramify on the bronchial tubes, and join the general capillary system. The bronchial veins, which return the blood, terminate principally in the pulmonary veins.

The immense pulmonary artery carries the whole of the venous blood of the body to the capillaries, which are spread over the air-cells for the purpose of aeration; and from these capillaries the radicals of the pulmonary veins commence, which convey this aerated blood back again to the left side of the heart.

Upon the air-cells is arranged the general capillary system, formed from the branches of the pulmonary artery, and giving rise to the radicals of the pulmonary veins. There is no evidence to show that a double layer of capillaries exists between two contiguous cells; but a single layer is placed between them, and this layer varies in extent in different parts.

Internal to this plexus of vessels is the lining membrane of the air-cells, which partakes of a *fibrous* character. This plexus is not confined to the air-cells merely, but also sends branches into the interior of the bronchial tubes, where it ramifies in the mucous

membrane, and communicates with the nutritious arteries of the bronchial tubes.

By this beautiful and simple contrivance the whole of the venous blood, in health, is constantly exposed to the oxygen existing in the atmospheric air which fills the air-cells; inspiration admitting atmospheric air, and expiration expelling carbonic acid gas, nitrogen, and watery vapour—the products of respiration.

Reisseissen and Mr. Addison say, that in the fœtus the ultimate bronchial subdivisions are tubular; that they have a regularly branched arrangement, ramifying symmetrically in all directions, and terminate without anastomoses in closed extremities, which are generally situated at the boundaries of the lobules; that when an animal has once respired, the entrance of the air into the lungs distends the lobules, and the ultimate bronchial subdivisions undergo such a change, from the feeble resistance to the pressure of the air into the cells, that, meeting on all sides, they form various hexagonal and pentagonal figures, so well seen in a thin layer of inflated and dried lung. But Mr. Rainey and Mr. Grainger have shown that the air-cells in many fœtal animals, which had never once breathed, were developed proportionally with the other parts of the lungs.

The medulla oblongata is the ganglion of respiration, all the nerves concerned in that function being directly or indirectly connected with that part of the cerebro-spinal axis. Among the *excitors* of respiration may be placed—1. The par vagum. 2. The sympathetic nerves. 3. The ophthalmic and submaxillary branches of the trigeminus or fifth pair. And among the *motor* nerves—1. The pneumogastric. 2. The phrenic. 3. The intercostals. 4. The facial. 5. The spinal accessory. 6. The external respiratory of Bell. The pneumogastric is an excitor, because it is an afferent nerve in virtue of its sensory function, (containing sensory fibres;) and a motor, partially in consequence of the motor fibres, which it receives directly after its origin from the spinal accessory. The pneumogastric, spinal accessory, the fifth pair, and the facial, all arise from the medulla oblongata; but the inter-costals, the phrenic, and the external respiratory of Bell, are connected with the spine, and through that with the medulla oblongata.

The materials of which the blood is composed, passing through this wonderful texture seventy times in a minute, are also of some

interest. It consists of red particles, colourless globules, and liquor sanguinis. Andral and Gavarret have adopted, as a standard of healthy human venous blood, the following :—

Water	790
Red particles, discs, globules, or corpuscles	127
Fibrine and colourless globules	3
Albumen, serum, oil, &c	72
Salts, consisting of chlorides of sodium and potassium ; lactate of ammonia ; phosphates, carbonates, and sulphates of lime and magnesia ; and the lactic, carbonic, phosphoric, sulphuric, and fatty acids, in combination with bases of soda and potash	8
	1,000

In the different processes of anæmia, hyperæmia, and its results, up to inflammation and its terminations, each of these constituents of the blood undergoes a marked alteration, which the late investigations into pathological chemistry and microscopic anatomy have clearly and beautifully delineated.

These developments of exudation corpuscles from the liquor sanguinis form, according to the different proportions of fibrine, albumen, and red globules contained in each, the various deposits so well described by Dr. C. J. B. Williams and Dr. Hughes Bennett as plastic, euplastic, cacoplastic, and aplastic lymph ; the correct knowledge of which deposits has a great influence over the pathological phenomena and successful treatment of diseases of the chest.

Reflecting on the peculiar texture of the lungs, and the quantity and quality of blood which is sent through them at each stroke of the heart, and considering the excessive tenuity and delicate structure of the air-cells, which, when the lungs are inflated by inspiration, exposes an area equal to 1,500 square feet, and at which very moment the greatest quantity of blood rushes through them—giving to the touch the feeling of an elastic bulging gauze-like cellular substance—we cannot be surprised that disease of these organs should be so frequent and so fatal.

The accompanying drawings, No. 1, Plate 1, and Nos. 2 and 3, Plate 2, of the appearance of human lungs, injected by Mr. Rainey and my son, and viewed under a microscope of 37 to 50 powers

linear, show the manner in which the blood from the pulmonary artery is conveyed round the air-cells.

In a paper of this nature, the utmost allowed limit of which is to occupy one hour only in reading, it would be not only presumptuous, but totally impossible, however original the opinions of the writer, to draw the attention of such an audience as this to a rapid survey of the whole catalogue of diseases of the chest; and as I merely intend to compress into this discourse what I think will be found most useful in assisting those who do not make such diseases their particular study, in detecting and treating them more successfully, I shall endeavour to notice those affections which are either the most interesting or most dangerous, beginning with the diseases of the air-tubes, and proceeding with those of the pleura, tissue of the lung, and, lastly, some of the diseases of the heart.

In describing the different means of diagnosis, the author has not been unmindful of two most useful instruments, invented by members of this Association, which give such correct information, and throw so much light on doubtful cases of chest affections, as to strongly urge the recommendation of their general use,—viz., the "Chest measurer," being the invention of my friend, Mr. Francis Sibson, of the Nottingham Hospital, to whom this Association owes already a deep debt of gratitude for his elaborate and useful paper, "On the Changes induced in the Situation and Structure of the Internal Organs under varying circumstances of Health and Disease, and on the Nature and External Indications of these Changes;" and a subsequent paper published in the *Philosophical Transactions* for 1846, "On the Mechanism of Respiration;"—and the "Spirometer," invented by my friend, Mr. J. Hutchinson, of London, who has read a most scientific and practical paper, "On the Capacity of the Lungs, and on the Respiratory Functions, with a view of establishing a Precise and Easy Method of detecting Disease by the Spirometer," before the Royal Medico-Chirurgical Society, which is published in the twenty-ninth volume of their *Transactions*. These instruments, in addition to our corrected means of ascertaining disease through the medium of percussion and auscultation, and aided by

the advancing progress of pathological chemistry, if steadily pursued, will, we confidently predict, eventually render the whole range of chest affections very easy and certain of detection.

Bronchitis.—Under this division may be included the various species of acute and chronic catarrh, acute and chronic bronchitis, bronchial congestion, bronchorrhœa, humeral asthma or pituitous catarrh, and their effect, structural lesion of the air-tubes.

As long as inflammation is solely confined to the mucous membrane of the bronchial tubes, the capillaries of which arise from the bronchial arteries, percussion gives a resonant sound, notwithstanding the disease may be exceedingly dangerous. But, in rickety persons and in old people, where the ribs become more fixed at their attached extremities, there may be so much dulness on percussion as to deceive the auscultator. This state requires great care and caution in strictly making out the air-murmurs in respiration; which, in pure bronchitis, are first dry, sibilant or whistling, droning or sonorous; and, as the disease advances, moist mucous or bubbling rhonchi, the natural breath-sound or vesicular murmur being scarcely heard. Whenever these rhonchi exist, combined with crepitant rhonchus and dulness on percussion, the inflammation has attacked the fibro-serous membrane of the air-cells, and pneumonia, with its exudation of fibrine, serum, and red blood-globules, is the result, as in that dangerous disease which attacks the aged, called by Sydenham, peripneumonia notha.

There is often a ticking sound heard, which we were at a loss to account for. Dr. C. J. B. Williams considers it caused by a pellet of thick mucus, acting like a valve, at the entrance of a bronchial tube, and which may often be removed by coughing.

When both the dry and moist sounds are heard together, the disease has attacked the smallest bronchial tubes, and prevents air entering the air-cells,—a state of great danger, often producing asphyxia.

The state of the expectoration is a good index to the pathological condition of the bronchial membrane. Whenever the expectoration is very viscid, containing large quantities of fibrine, pus, and blood, ascertained by examination under the microscope, it shows the acute stage of inflammation; when it becomes opaque, concocted, and is secreted in large quantities, the activity of the disease is declining.

The liver becomes congested, the fæces clayey, and the carbon, which ought to be secreted by the lungs and liver, goes off by the kidneys, the urine being loaded with hippuric and uric acids, and urate of ammonia.

In measuring the expansion of both sides of the chest in inspiration by the chest-measurer and tape, very little difference will be found, particularly after a good fit of coughing, and the vital contents of the chest, measured in cubic inches by the spirometer, will not very materially differ from that of health; whereas, in phthisis these two modes of examination give decided and very marked evidence.

We often find wheezing, spasmodic and convulsive cough, kept up, I believe, by the excessive, defective, or irregular contractions of the circular fibres of the bronchial tubes, the consequence of long-continued inflammatory action. In such cases, anti-spasmodics are the best remedies.

Baglivi says, "*In morbis pectoris ad vias urinæ ducendum;*" and we find diuretics act most efficiently and favourably in chronic bronchitis, when every other remedy has failed. Whether this relieves the congestion of the mucous membrane of the air-passages by carrying off through the kidneys what ought, but cannot be exhaled from the lungs, is not proved; but there is no doubt of the fact.

The method of distinguishing chronic bronchitis from phthisis pulmonalis will be considered when we speak of the latter disease.

Laryngismus Stridulus.—It would not be right to omit noticing a very distressing and dangerous nervous affection in children, properly termed laryngismus stridulus, but which has borne the names of asthma infantum, crowing disease, spasmodic croup, spasm of the glottis, &c. A good deal of interesting discussion has taken place latterly on the pathology of this affection. The late Dr. Ley and others were of opinion that the spasm of the glottis was occasioned by enlarged glands or other tumours, compressing and partially paralysing the recurrent or inferior laryngeal branch of the par vagum; others ascribed it to incipient disease of the brain; but I am inclined to think the explanation of it given by Dr. Marshall Hall, as a reflex nervous affection, is the most satisfactory. In Dr. Hall's new Memoir of the Nervous

System, Mr. Simpson, of Stamford, gives a plate, which exhibits most beautifully the pathology of this disease. The dental branches of the trifacial, and the gastric and intestinal branches of the pneumogastric, which, being irritated, convey impressions through the medulla oblongata and medulla spinalis, and their effects on the reflex nerves, produce strabismus, partial and complete closure of the larynx, tetanic fingers and toes, strangury, tenesmus, rapid inspiration and violent expiration, suppression of the bile and urine, and congestion of the brain. Sometimes death is quite instantaneous, without the slightest precursory symptom.

Some time ago I had an interesting little patient, who was thrown into a complete state of emprosthotonos during the course of the disease; and there are cases of the same description on record.

The treatment which has been found most successful, viz.,—scarifying the gums down to the alveolar processes, active purgatives, a healthy wet nurse, mild unirritating diet, warm clothing, change of air, the avoiding of cold wind and draughts of air, and often the instantaneous good effect of dashing cold water over the child immediately after coming out of a hot bath, during a paroxysm, also add to the probability of the correctness of Dr. Marshall Hall's theory. The absence of fever and cough, suddenness of the attack, and freedom of respiration during the intervals, sufficiently distinguish this disease from all others.

Very troublesome cases of convulsive cough are met with, generally in young hysterical females, which often puzzle the practitioner. I was called to a case of this description not long since, where the young lady, aged fourteen, who had never menstruated, had been coughing incessantly for some days and nights, without the least intermission. The cough was of the croupy character, with a peculiar ringing bark, and so loud that it was heard all over a large house, and at a considerable distance in the grounds, even when the window of her room was shut. During the actual time of coughing no respiratory murmur was heard in the chest; but in the short intervals, puerile, and a peculiar tubular respiration, with a quick and loud expiratory breath-sound, was very evident. As soon as the cough ceased in the least degree, tetanic spasms came on in almost every limb,

and continued until they were relieved by the return of the cough. In the absence of any other physical signs of disease of the chest, I considered these symptoms to be most likely owing to reflex nervous action, arising from irritation of the incident nerves of the uterus, stomach, bowels, and larynx; and eventually I overcame the spasmodic action by perseverance in a purgative and iron tonic treatment, combined with occasional large doses of morphia to procure sleep, and the very frequent use of the cold salt-water shower bath.

Spasmodic Asthma.—It is now well known, both from Dr. Todd's and Mr. Bowman's microscopic, and Dr. C. J. B. Williams's ingenious physiological researches, that the air-tubes are encircled with muscular fibres; and the phenomena of pure spasmodic asthma, as well as its successful modes of treatment, leave little room to doubt that spasmodic contraction of the air-passages is a reflex action, excited by various causes, and the par vagum the nerve concerned in producing it.

The greatest difficulty to surmount in this disease consists in distinguishing it from some of the organic diseases of the heart and lungs, which produce symptoms so exactly similar, that the term asthma has become almost a by-word for such diseases. The frequent recurrence of spasmodic asthma has also a tendency to produce organic changes in the heart and lungs, particularly dilatation and hypertrophy of the right ventricle, and dilatation and hypertrophy of the air-tubes and cells, pulmonary congestion, and hæmorrhage.

In pure spasmodic asthma, without structural disease, during the attack, no true respiratory murmur can be heard, notwithstanding that all the ordinary and supplementary muscles of respiration are brought into action by the violent efforts made to overcome the spasm: but if we make a patient labouring under an attack hold his breath altogether for a few seconds, or while he counts aloud thirty or forty, and then let him quietly breathe again, the air will be heard to enter freely into every part of his lungs, until, in a few more breathings, the spasm regains its hold. And in the absence of an attack, the patient will be enabled to raise the spirometer to the natural or healthy standard; whereas, if the asthma be caused by organic disease of the heart or lungs,

neither of these signs will be present. The physical signs and symptoms of these organic diseases will be noticed under that division of our subject.

A large quantity of limpid urine, of a low specific gravity, without any deposit, similar to that in hysteria, constantly attends spasmodic asthma; but when organic affections are the cause, the secretion of urine is less in quantity, generally loaded with urate of ammonia or uric acid, and is of a high specific gravity.

In pure spasmodic asthma, the expectoration, which always relieves the spasm as soon as it is secreted, is purely mucous; but when it is complicated with disease of the heart or lungs, both serum and fibrine are exuded. This makes the expectoration very viscid, and adds materially to the distress of the patient.

During a pure asthmatic attack the chest may be duller on percussion than natural, owing to the contracted state of the lungs when under the influence of the bronchial spasm, as the walls of the chest are then forced inwards by atmospheric pressure, and do not vibrate freely; but this dull sound is quite distinct from that caused by consolidation, infiltration, effusion, or hypertrophy. And in the interval of the spasmodic attacks, there is always considerable dyspnœa remaining, when the asthma is the effect of some organic change, which is not felt otherwise.

The constant congestion which is kept up in the lungs from repeated attacks of pure spasmodic asthma, eventually produces very great congestion in the vena portæ and liver. Bile is not secreted by the liver; the alvine evacuations become white, and the carbon, soda and other salts, and colouring matter of the bile, are re-absorbed into the venous system, and ultimately carried off by the kidneys in the forms of hippuric acid, urate of ammonia, purpurine, and biliphæin.

The inhalation of æther, particularly chloric, has latterly been found decidedly efficacious in checking the progress of an asthmatic paroxysm. A very simple apparatus is quite sufficient for the purpose.

Pneumonia consists essentially in inflammation of the air-cells; these are lined by a membrane of a *fibro-serous* character, which has no resemblance whatever to mucous membrane or muscular fibre, either of the striped or unstriped kind. The ordinary

pneumonic deposits are poured into these cells, exclude the air, and of course prevent the decarbonization of the venous blood. The lobular structure of the lungs, each lobule having its own supply of arteries and veins, has the tendency to prevent that rapid spread of inflammatory action which would otherwise take place and produce extensive ravages. This wise and conservative provision of nature claims our highest admiration!

Pneumonia is usually divided into three stages. The first, called engorgement, or simple inflammatory injection of the membrane, with serous effusion into the cells, partially obstructing the ingress of air, which is consequently forced through the cells in successive bubbles, producing that ominous and invaluable breath-sound, the crepitant rhonchus, without dulness on percussion, with viscid expectoration, which soon becomes semi-transparent, tenacious, of a reddish-yellow, or rusty tinge. The dark colour of the expectoration indicates its formidable source, having its origin in the exudation from the capillaries of the large pulmonary arteries, which are distributed on the air-cells, carrying venous blood, and not from the bronchial arteries. The second, or hepatization, is ascribed by Dr. Williams to the deposition of semi-solid albumen in the interstitial and intercellular tissue; but latterly, by Dr. Thomas Addison, of Guy's Hospital, to the absorption of the serum previously effused into the turgid cells, which, coalescing, occupy or fill up these cavities, and occasion the consolidation called by authors "red hepatization," producing bronchial or tubular respiration, bronchophony, and perfect dulness on percussion,—the sputa remaining rusty, or becoming opaque, mucous, or watery. And the third, or purulent stage, indicated by the gurgling mucous rhonchus, continued dulness on percussion, and dirty, purulent, and offensive expectoration.

But Dr. Stokes, of Dublin, has sufficiently proved that, before any crepitant rhonchus can be heard in this morbid condition, there is a preternatural dryness of the air-cells from an arrest of their natural secretions, which produces an excited state of the respiratory act, and causes a louder and rougher respiratory murmur than natural.

This we consider a very valuable addition to our knowledge of the physical signs of pneumonia, and have often found its efficacy in detecting pneumonic inflammation in cases of continued fever

earlier than otherwise we could have done; but in order to discover this, the patient must forcibly inhale and exhale the air.

Dr. Thomas Addison is of opinion that this loud and rough respiratory sound is the physical sign of pure pneumonia only; and that when the crepitant rhonchus exists, it is accompanied by inflammation of the minute bronchial vessels.

The ciliated epithelium, which is peculiar to the air-passages, lines the bronchial tubes only as far as the termination of the bronchial membrane, and does not extend beyond this membrane into the bronchial intercellular passages, or into the air-cells: most probably the air-cells alone, beyond this ciliated epithelial lining, are really the first portion of the lung implicated in pure pneumonia.

If the air-cells of the lung of a patient who has died in what is usually considered the first stage of pneumonia (that of engorgement,) be carefully pricked or pressed out, there will exude a quantity of fluid from them, which careful examination by heat and under the microscope proves to contain serum, fibrine, and red blood-globules. But if the contents of the air-cells in the stage before this be examined, a very small quantity of fibrine only will be found. This may be considered one mode of distinguishing the difference between the first two stages of the disease, and also shows the cause of the different breath-sounds already described.

In the very first stage we suppose the air-cells alone are implicated, and fibrine alone exuded. The air passes this with a little difficulty, and the physical sound is merely a louder and rougher respiratory murmur. But in the stage of engorgement, not only the cells, but the intercellular passages and smallest terminations of the bronchial tubes, become implicated; serum and red blood-globules, in addition to fibrine, are exuded: this increases the difficulty which the air has to overcome in passing to the cells, and is the cause of the crepitant rhonchus.

Dr. Addison lays great stress on the difference between red and grey hepatization; and, in reference to the progress of the red hepatization, says,—"From examinations I have made of lungs in this state, I am disposed to agree with those who reject the notion of the consolidation being dependent in any degree upon actual effusion of solid albuminous matter into the cells,

It seems to result entirely from the great vascularity, softening, and tumefaction of the parietes of the cells themselves; and hence, probably, the rapidity with which this often takes place in typhoid or cachectic pneumonia, in consequence of that loss of tone which uniformly causes the various tissues speedily to soften, under the disorganizing influences of inflammation."* A portion of lung in this condition, under a low microscopic power, has a granular appearance, but shows no actual deposit in the cells.

The healthy organizing process converts albumen into the various natural tissues; whereas inflammation tends to destroy this organization, and to cause the tissues to return to an albuminous state. And, as acute inflammation proceeds, the parietes of the cells become more and more opaque, the minute blood-vessels are no longer visible, the cells become softened, and with this extreme loss of cohesion, and apparently diminished vascular turgescence, we have undeniable proof that the cells now admit of an albuminous matter being poured into their cavities. This constitutes grey hepatization.

In the red hepatization the lobules can easily be distinguished; but in the grey, the whole portion of lung appears of the same colour, and the cellular membrane which separates the lobules is lost sight of.†

Notwithstanding the tissue is so much softened and its cohesion lost, we seldom or never find an abscess in the lung, unless it be in consequence of phlebitis, surgical operations, hooping-cough, or in very bad cachectic habits; and gangrene is quite as rare.

Dr. Addison considers the permanent effect of pneumonia to be—1st. The uniform albuminous induration, when the albumen becomes an organized mass—a rare termination. 2nd. Granular induration, generally called "inflammatory tubercle," and terminating similarly to phthisis.‡ 3rd. Grey induration, when the yellowish-white and black pulmonary matters become mixed, and which is generally called "tubercular infiltration."§. The two last-named terminations are so exactly like phthisis pulmonalis in their symptoms and progress, that it brings pneumonia so closely on the verge of that horrible scourge of our population, as to render its inquiry equally serious and interesting, and which will be noticed at length hereafter.

* See Plate 1, Fig. 2. † See Plate 4.

‡ Plate 4, Fig 8. § Plate 4, Fig. 7 and 8.

As these morbid changes have been considered forms of tubercular infiltration, it may be fairly asked, what proof have we of their inflammatory origin? In answer—1st. We occasionally have direct proofs of a previous attack of acute inflammation within the chest. 2nd. They are accompanied by the clearest evidence of former inflammation, namely, old deposits on the pleura, immediately above the affected portion of lung; adhesions between the pleuræ in that situation; puckering of the pleura, with contraction and diminution of size of the lung itself, sufficient, in some instances, to cause actual deformity of the thoracic cavity.* 3rd. They are more frequently found in the middle and inferior lobes, and not in the apices, the usual and earliest seat of tubercle. 4th. The absence of tubercle in every other part of the body.

Persons labouring under pneumonia will invariably be found very deficient in the vital capacity of the chest, as ascertained by the spirometer. They lose weight during the continuance of the disease, but speedily make it up as the disease declines. The reverse of this is observed in phthisis.

If acute pneumonia have already proceeded to complete hepatization when we first examine the patient, the physical signs alone are not unfrequently insufficient to distinguish the morbid change from phthisical disease, or from ancient pulmonic induration, with or without dilated bronchial tubes. This is more especially the case when acute pneumonia assails the apex of the lung—by no means uncommon. Under such circumstances the spirometer becomes useful, and the previous history of the patient is very important.

When pneumonia occurs in its simplest form there is often no cough nor expectoration, and the case so closely resembles common continued fever, that both the auscultator and non-auscultator are liable to be thrown off their guard. But, by watching closely, auscultation will be sure to discover either the physical rough and loud murmur, or the crepitant rhonchus.

Physical examination does not enable us to distinguish an advanced stage of pneumonia with bronchitis; from pneumonia with breaking up of the lung—a difficulty the more embarrassing, as the former may pass into the latter.

When the anterior and inferior portion of the left lung is consolidated by pneumonia, if the stomach be full and flatulent,

* See Plate 4.

percussion may produce good resonance; and when consolidation takes place anteriorly, inferiorly, and even posteriorly, on the right side, a tympanitic state of the intestines may give a resonant sound. Under similar circumstances, amphoric respiration and metallic tinkling may be heard, leading to the erroneous conclusion that pneumothorax is present. In these cases the spirometer will materially assist our diagnosis.

Dr. Addison remarks that physical examination cannot always determine whether pneumonia, in any of its forms, have, or have not, supervened upon tubercles, although the prognosis in the two cases would be very different.

When serous effusion is very considerable, giving rise to bronchophony, tubular respiration, and want of resonance and vocal vibration, auscultation may lead to a mistaken belief that these signs result from pneumonic or other consolidation, and the history of the disease must be investigated.

Cases may happen where pleuritic effusion is confined to the middle lobe of the lung, and it is difficult to determine whether the dulness on percussion be owing to effusion or hepatization.

A patient with a febrile disorder may have dulness on percussion, tubular respiration, bronchophony, and a rhonchus like that of mucous or sub-mucous crepitation from hepatization, and auscultation cannot determine whether it be recent or not.

A portion of lung may be compressed by effusion, and prevented from expanding by adhesions. The physical signs may be permanent, and resemble those from recent pleuro-pneumonia.

In doubtful cases, the use of Mr. Sibson's chest-measurer is very valuable, as it immediately shows that the affected side moves much less during inspiration than the sound one.

Acute pneumonia, where the inflammation is energetic, the quality of the blood good, the lymph plastic, and the recovery complete, is very rarely met with. The most frequent cases occur in habits where, from long-continued previous disease, such as fevers, pleurisy, &c., the blood is poor in red particles, and the inflammation of a low character, producing cacoplastic and aplastic exudations, which are gradually converted into, or replaced by, tuberculous matter.

When the lungs are so disorganized as to interfere with their proper function of carrying off the carbon of the decayed tissues,

and the fever so high as to occasion a great waste of tissue, the liver and kidneys endeavour to compensate, and so keep up the balance in the excretory system. Thus we find the liver becomes congested, the alvine excretions very dark in colour, owing to the increase of carbon in the vena portæ; and the urine becomes very acid in its reaction, loaded with urea, uric and hippuric acids, sulphate of potash, phosphate and carbonate of soda, chloride of sodium, and often albumen and mucus. When the third stage of pneumonia lasts long, the liver becomes so unable to carry off its additional load of carbon, that it is not uncommon to find purpurine as well as pus-globules in the urine.

If we consider what the part diseased is—the lung, and what the disease – inflammation, we cannot too highly value the earliest sign, however simple and mean, which gives the certain intimation that a disease is in existence which tends to rapid disorganization and inevitable loss of life, unless quickly arrested by its counteracting remedies. But, from our knowledge of the very frequent termination of pneumonia in that hitherto unconquerable and unmerciful disease, phthisis pulmonalis, it behoves us to use our remedies with sufficient promptitude and caution, to allow us the reasonable chance of first cutting short the inflammatory action, while at the same time we do not unnecessarily reduce the quantity and quality of blood, and powers of life, in our patients.

We believe no better mode of treatment can be adopted than that well known to the profession,—bleeding, antimony, and mercury, with counter-irritation. But the extent to which this treatment should be carried in each individual case, depends so much on the constitution and habits of the patient, and its ultimate effect, that it would be unwise to say more on that subject here.

It may be allowed, in conclusion, to remark, that we consider percussion and auscultation the only safe guide in directing the extent of treatment necessary for each individual case; and, although aware of the difficulties and fallacies connected with them, we still indulge a hope that, as this method of investigating disease becomes thoroughly well understood by all classes in our arduous profession, there will be fewer cases of pneumonia terminating in phthisis.

Pleuritis.—This is a disease equally as interesting to the practitioner and dangerous to the patient as pneumonia; and until auscultation unravelled its true nature, it was very generally misunderstood, almost every pain in the side, particularly if accompanied by cough, having been designated by the appellation.

It is inflammation of the serous membrane which invests the lungs and lines the ribs; the pleura,—a shut sac. The capillaries of the membrane, when inflamed, exude coagulable lymph, serum, and blood; but it depends upon the character of the blood, as well as upon the nature of the membrane inflamed, what the products of the inflammation will be. Thus, in pleuritis, if the blood be excessive in red particles, as in very robust and healthy persons, there will be coagulable lymph, serum, and blood exuded; the inflammation will be active, and the termination, on account of the activity of the absorbing vessels, generally favourable. The blood may be deficient in red particles, as in anæmic, lymphatic, and leucophlegmatic subjects, and tubercular deposits will be formed. If fibrine predominate, the serous membrane will be covered with a thicker and more adhesive layer of lymph, of the most plastic character, and adhesion will result. But the blood may be so altered in quality as to produce even osseous deposits. The fibrine may be so low in character as to allow only aplastic lymph to be secreted; in which case, very slight, if any, adhesion would take place, and pus, curdy matter, yellow tubercle, &c., would be deposited. It might be euplastic, and become highly organized, or cacoplastic, and susceptible of only a very low degree of organization, particularly in the chronic stage; thus giving origin to fibro-cartilage, grey tubercle, &c.

Pleurisy and pneumonia commonly co-exist, termed pleuro-pneumonia or pneumo-pleuritis, as one or the other predominates.

The most remarkable and dangerous consequences resulting from pleurisy are those arising from effusion of the coagulated lymph on the opposite surfaces of the membrane, which unite by adhesion, and partially obliterate the cavity; while, at the same time, a large quantity of serum, blood, flaky lymph, pus, and other exudation, may compress the lung close up to the spine, and prevent the possibility of the air re-expanding it. The mediastinum is pushed towards the opposite side, the intercostal muscles bulged out, and the diaphragm depressed, so that the lung, although

healthy, is perfectly useless. This takes place in various parts of the chest; and although, usually, we may expect to find the fluid at the inferior part, it often happens that, in consequence of previous adhesions of the pleuræ, we find a resonant part of the lung below a part compressed by effusion. The serous part of this effusion gradually becomes absorbed in many cases, but so slowly as to prevent the re-inflation of the lung; and then the walls of the chest are compressed externally by the atmosphere, laterally by the contents of the sound side of the chest, and inferiorly by the abdominal viscera, so that it is no uncommon occurrence to find the heart driven over to the right side, or pushed under the axilla in the left, or dragged, after the fluid becomes absorbed, to the opposite side, and the figure of the chest becomes so altered as to require great care and caution in making a physical examination.

In addition to all this, we have to contend with the aplastic and cacoplastic deposits, the loss of oxygen, circulation of venous blood, abnormal pressure on the abdominal viscera, and the gradual effect of this upon the liver, stomach, and kidneys, which eventually become congested and otherwise diseased.

Then we have the combinations of pleurisy with phthisis or other causes, producing pneumothorax; pleurisy, from a fractured rib admitting air not only into the cavity of the pleura, but into the areolar tissue beneath the skin, producing emphysema. A more wretched picture of human misery cannot be sketched than a patient labouring under the extreme effects of pleurisy.

What are the physical diagnostic signs then—first, of the pleura being coated with coagulable lymph? secondly, of the existence of fluid in the pleural cavity? thirdly, of pneumothorax and emphysema?

1. The immobility of the affected side; the pleural friction-sound, produced by the rubbing together of the dry or inflamed and roughened surfaces. This is a creaking sound, of an interrupted character, occurring in a series of three or four jerks; it may often be felt by placing the hand upon the corresponding surfaces of the thorax. This sound is sometimes not heard at all, because it is not listened for at the time it exists; for as soon as either the membranes unite, or are separated by fluid, this sound ceases. A little dulness on percussion at the base of the

lung generally attends this friction-sound, and the dulness comes on sooner than in pneumonia.

2. When fluid exists there will not only be, first, dulness on percussion; but, secondly, a proportional diminution of the intensity of the respiratory murmur: it will be heard farther off than usual, because the lung is gradually pressed towards the spinal column, or upwards and inwards towards its roots. The fluid will press both on the lung and bronchial tubes, and there will be, thirdly, bronchial respiration, bronchial voice or ægophony, and bronchial cough. When the pleura is quite full of fluid, the lung will admit no air; that side of the chest will be motionless, larger than the opposite side, with its intercostal muscles bulged out, and neither bronchial nor any other breath-sound will be heard. This is sufficient to distinguish it from pneumonic consolidation. The bronchial voice or ægophony is produced by the rapid undulations communicated to the effused fluid by the vibrations of the bronchi and condensed pulmonary tissue, and is generally heard best at the inferior angle of the scapula, when the patient is sitting up in a chair. Fourthly, the total loss of vocal vibration; and fifthly, the respiratory murmur is puerile in the sound side.

But these are precisely the physical signs of pneumonia. How are we to prove they are occasioned by pleurisy? First, unless there be previous adhesion of the pleuræ to prevent, the fluid will always be the most dependent part of the chest, in whatever situation the patient is placed; therefore, by changing his position, we find the upper part of the chest resonant, and the under flat. It is seldom there is so much hepatization, or so much tubercular disease, as to make the lungs sound flat all over, from the apex to the base; so that when a pleural cavity is quite full, the perfect uniform dulness will be nearly a positive sign.

When the intercostal muscles are bulged out, the affected side, if measured with a tape, will be found from one to two inches larger than the sound one. Dr. Watson states a case of aneurism, where the whole pleural cavity was filled with clotted blood that was considered, by physical examination, to be pleurisy.

When the fluid has partly been absorbed, the diseased side measures less than the sound one. The effect of atmospheric pressure is sometimes so much as even to bend the vertebral column, and produce lateral curvature of the spine. In doubtful cases, the spirometer will materially aid our diagnosis.

3. In pneumothorax the air occupies the highest, and liquid (generally pus,) the lowest, portion of the pleural cavity, in all positions. Percussion gives a remarkably hollow tympanitic sound at the top, and is immediately changed to a very flat sound below, which will be more marked on comparison with the other side. No respiratory murmur, nor vocal sound or resonance, can be heard through this air. When the patient breathes, speaks, or coughs, amphoric resonance is heard, and this is often succeeded by an echo, called metallic tinkling. Succussion of the patient's body enables a liquid splashing to be heard, when the ear is close to the body, as well as metallic tinkling. This is the oldest physical sign known, as it is mentioned by Hippocrates in the following words :—

"Λούσας πολλῷ θερμῷ καθίσας ἐπὶ ἐφέδρου, ὅ τι μὴ ὑποκινήσει ἕτερος μὲν τὰς χεῖρας ἐχέτω, σὺ δὲ τὸν ὦμον σείων, ἀκροάζεσθαι ἐς ὁκότερον ἂν τῶν πλευρέων τὸ πάθος ψοφέῃ."

In emphysema the affected side is larger, remarkably tympanitic on percussion, without any natural respiratory murmur, but with a sibilant rhonchus in the place of the expiratory murmur, and there is emphysematous crackling.

The pathognomonic symptom of the decubitus is worthy of an observation. In the first instance, the patient cannot lie on the affected side, because of the pain on pressure; he lies, therefore, on the sound side, or on his back. At a more advanced period, when the effusion is greater, he cannot lie on his sound side, because the compression of the sound lung, from the fluid of the diseased side above and the bed below, prevents him using his respiratory organs freely; he, therefore, lies on the diseased side, or in a diagonal posture, between his back and the diseased side.

Pleurisy may be mistaken for pleurodynia, nerve-ache, rheumatism of the intercostal muscles, hepatitis, and pneumonia.

In pleurodynia there is no heat of the skin, and the pulse, although increased in frequency, yet is wanting in that hardness which accompanies pleurisy. There is also the absence of the short and embarrassed respiration, friction-sound, and dulness on percussion, and sometimes there is a rumbling sound produced by the vibrating contraction of the muscles, which is kept up by the sensation of pain; and it generally occurs in a condition of the

system the very opposite of inflammatory, as after considerable losses of blood, or when the blood is impoverished, as in chlorotic females.

Nerve-ache, in addition to the absence of fever and the physical signs of pleurisy, generally occurs in paroxysms, and is often ushered in by a sensation of numbness, creeping, or pricking, in the affected part, and its cessation may be preceded by itching: it generally attacks the intercostal nerve running between the eighth and ninth ribs.

In rheumatism of the intercostal muscles there is seldom any fever; there is absence of the physical signs of pleurisy, and aggravation of the pain on pressure or movement of the muscles, and sometimes a sense of coldness in the affected part.

In addition to the physical signs of pleurisy, the distinction between inflammation of the pleura and of the liver may be made by the absence of increase of pain on pressure over the hepatic region, as well as that sallowness of countenance which generally attends hepatic affections, and the absence of the shoulder pain in pleurisy. The use of Sibson's chest-measurer and the spirometer will also assist in distinguishing these diseases, as the loss of respiratory motion in the side affected by pleurisy will be well marked.

Hydrothorax arises either from the effect of disease of the heart, or from a low kind of inflammation of the pleura, not terminating in adhesion, or as the effect of chronic pleurisy. I lately attended a case of the former description, where seven pints of fluid were found after death. The effusion into the pleura has no offensive smell unless atmospheric air has been admitted, either through an aperture in the walls of the chest, a pulmonary fistula leading to the trachea, or a hole in the œsophagus communicating with the trachea.

Having taken up much of the valuable time of the Meeting in endeavouring to point out what auscultatory signs are to be depended upon in recognizing pleurisy and its effects, I will conversely give a few facts, lately advanced by Dr. Thomas Addison, to show how fallacious some of them are, if exclusively taken.

The permanent effects of old pleurisy on both sides of the chest, bronchitis, hepatization, hypertrophy and dilatation of the heart,

abdominal effusion, enlarged liver and spleen, alter the state of the thoracic viscera so much as frequently to mislead the auscultator, and these cases require the greatest care in their exploration.

When pleurisy occurs low down in the angle between the ribs and diaphragm, anteriorly, (the paraphrenitis of the ancients,) many days may elapse before either pleuritic rubbing or any other pleuritic sign can be heard; and percussion is fallacious on account of the proximity of the liver and stomach. From the same cause, when the effusion is purely serous, and it gravitates to the floor of the cavity, unless it be very abundant, it may escape detection.

Physical examination cannot always distinguish the rub and crepitation of pleurisy in the lowest part of the chest, from similar sounds resulting from recent adhesions between the liver and diaphragm or abdominal parietes; and sometimes croaking bronchial rhonchi very much resemble the rubbing sound.

The friction-sound of pericarditis may sometimes be mistaken for pleurisy; but by attentively listening, the *double* or *to-and-fro* friction of pericarditis will be heard.

A lung rendered solid by inflammation does not distend the cavity and obliterate the intercostal depressions, nor displace the heart. Pleuritic effusion does. The bulged side can be measured in pleurisy.

A solid lung transmits the voice, and if any air remain, the respiratory murmur also; but these phenomena are wanting when the pleura is distended by fluid.

In a lung solidified by hepatization, the vibration of the voice is augmented; but it is prevented altogether by imprisoned fluid. When the pitch of the patient's voice is too high or too feeble, this test becomes useless.

A patient having one solid lung, is indifferent as to posture; but when one lung is full of fluid, he lies on or towards the diseased side.

The remarks made on the congestion of the liver and kidneys with their peculiar secretions in pneumonia, are equally applicable to pleurisy. When pus is effused in very large quantities, and the patient lives long in a hectic state, pus-globules are found in the urine, in addition to the other morbid deposits.

Very few words are necessary respecting the treatment of acute pleurisy. We believe the speedy specific action of mercury the

principal remedy to be trusted, after full bleeding. In the chronic states, the peculiar constitution and tendency towards tubercular disease require especial notice and care. Phthisis pulmonalis is a very frequent sequence of pleurisy.

Where there is a considerable quantity of fluid in the pleura, and the general health of the patient is beginning to suffer, it is the safest mode to perform paracentesis thoracis, and let out the fluid.

In *Guy's Hospital Reports* there are two very instructive essays on this subject by Dr. Hughes and Mr. Cock, worthy the attentive perusal of every member of the profession. They recommend the operation for hydro-pericardium, effusion of blood into the pleura, pneumothorax, hydrothorax, and empyema or chronic pleuritic effusion. There are twenty-five cases detailed, where it has been performed under their immediate inspection; in some of these many times. Thirteen have quite recovered; two partially; ten have ultimately died of other diseases, six of which were of phthisis. Out of these twenty-five cases, eighteen were for pleuritic effusion and empyema. After the case is clearly made out by auscultation, these gentlemen recommend the operation to be performed below the angle of the scapula, between the seventh and eighth, or eighth and ninth ribs—the former if possible—and at a point distant from one to three inches from the angles of the bones. They recommend introducing Dr. Babington's small-sized canula, containing a needle, first, to ascertain the contents; and afterwards a small trocar and canula, delineated by Mr. Cock. This instrument allows the fluid to drain off slowly, and prevents the admission of air. They do not approve of any of the instruments which have been invented to prevent the admission of air, as they have all signally failed. A small puncture is made through the skin, first, on the upper edge of the rib; the exploring needle and trocar are then introduced with a slight obliquity upwards, enabling it to clear the edge of the rib. The penetration of the pleura will be appreciated by the sensation conveyed to the fingers of the operator. The stream of fluid should continue unremitted, and never be interrupted during the whole operation.

Phthisis Pulmonalis.—Time will not allow us to go so fully into this most interesting subject as its importance demands.

A disease, which is sweeping from the earth daily, in numbers almost exceeding calculation, the most lovely and amiable of the human family, cannot be too much discussed; and, notwithstanding so little has hitherto been discovered to check the progress of this cruel enemy of mankind, we ought not to allow past failures to interfere with our efforts in endeavouring to ascertain:—First, what tubercle is? Secondly, how can it be distinguished from the ordinary products of inflammation, and from malignant growths? Thirdly, what are the earliest physical signs of tubercles in the lungs? And, fourthly, can any mode of treatment be adopted to prevent its ravages? A few brief remarks may be ventured on each of these points.

1. *What is Tubercle?*—After minutely describing every chemical analysis which has been made of tubercle for the last five years in this and other countries, Dr. Hughes Bennett, of Edinburgh, comes to the following conclusions:—"That tubercle consists of an animal matter mixed with certain salts, the proportions of which vary, animal matter being most abundant in recent, and earthy salts in chronic tubercle. It contains a large quantity of albumen; it is doubtful if it contain casein or gelatine, but certainly some fibrine and a good deal of fat: the earthy salts are insoluble phosphate and carbonate of lime, and soluble salts of soda. Very little difference in ultimate composition has yet been detected between recent tubercle and other, so called, compounds of proteine."

The microscopic appearance of tubercle of the lung is represented in drawing No. 5, Plate 3, magnified 250 diameters linear. A. is the net-work of the air-cells of the lung, constituted of filamentous tissue, presenting its natural appearance and arrangement. B. dense granular tubercular matter, which fills up the spaces or cells of the organ.

These granular corpuscles are made more transparent by the addition of weak acetic acid, but are otherwise unchanged. Æther and alcohol produce but little change: ammonia partly dissolves the corpuscles, and renders them capable of being broken down; they are completely dissolved in liquor potassæ. When tubercles are of a cretaceous or calcareous form, crystals of cholesterine are found mixed up with them, and they are often combined with the black pigmentary matter so frequently met with in scrofulous persons.

Tubercle may often be found under the microscope in the sputa of phthisical persons.* The fibrinous portion of the air-cells is then mixed up with the dense granular tuberculous matter, which may be dissolved by liquor potassæ, leaving the fibrine clear. It presents different appearances to the naked eye, according as it is hard or soft, cretaceous or calcareous.

But the best method of ascertaining the nature of tubercle of the lung, is by examining a tuberculous lung which has been successfully injected. Mr. Rainey says, "By this mode of examination it will be clearly seen that the tuberculous matter is poured from the free surface of the pulmonary membrane into the interior of the air-cells: these becoming distended, and the septa between the contiguous cells being at first compressed, and their vessels afterwards obliterated, the supply of blood to the diseased part is cut off, and a tubercle formed, corresponding in size to the number of distended cells."

It will be seen in the drawing No. 6, Plate 3, that some of the cells contain only a small quantity of deposit; others are completely distended with it, although their vascular walls remain entire. The vessels between the other cells are obliterated, and in some places the accumulation of tuberculous matter is so great as to compress the capillaries and cause their absorption; no vessels are left, and only the pulmonary membrane remains. In this state it is ejected by expectoration, mixed with tubercular matter, which may be detected by the microscope.

Mr. Rainey remarks, "An imperfect examination of the vascular connection of a tubercle with the surrounding air-cells in the injected lung, might give the idea of vessels passing into it from the adjacent unaffected parts, and thus lead to a supposition that it is vascular—an idea which has long been prevalent among pathologists. A careful examination, however, clearly shows that these vessels are merely portions of plexuses, which have not yet become absorbed." Tuberculous matter is deposited in the intercellular passages in the same manner, thus forming a large tubercular deposit. In this way the central part of a tubercular deposit will be farther and farther removed from those vessels which deposited the tubercle. It at length loses its vitality altogether, and, consequently, its cell or vegetable life, and becomes softened.

* Plate 3, Fig. 5.

2. *How can Tubercle be distinguished from the ordinary products of Inflammation, and from Malignant Growths?*—Principally by the microscope. The cells of cancer are large, transparent, and distinctly nucleated, and consequently easily distinguished from the small non-nucleated corpuscles of tubercle. The action of acetic acid distinguishes it from pus-corpuscles, for in tubercle the acid causes no granular nucleus to appear. From plastic corpuscles tubercle-corpuscles may be distinguished by their irregular form, smaller size, and the absence of primitive filaments; they can scarcely be confounded with the exudation or granular corpuscle, on account of its larger size, brownish or balckish colour, and nucleated or granular structure. There are certain fibrinous exudations, granular throughout, which it is very difficult to separate from the granular form of tubercle. This can only be done when the granules in the one case are associated with inflammatory, and in the other, with tubercular corpuscles. Dr. Bennett says, "Tubercles appear to me to be undeveloped cells, which are produced slowly, and have no tendency to form perfect organizations before they break down into a molecular matter."

Mr. Rainey says, "Some pathologists contend that tubercle is the result of inflammation. Without entering at length upon the consideration of this question, which is one *de verbo* and not *de re*, I may state that the perfectly natural appearance of the vessels close to a tubercle, and even of the cells containing a small quantity of tubercular matter, not sufficient to have impeded their circulation in the capillaries during life, when compared with the tortuous and unequally dilated state of the vessels going to the air-cells filled with fibrine in consequence of inflammation, are pathological considerations in favour of the non-inflammatory nature of phthisis. These facts go also to show that the obliteration of the capillaries between the air-cells is, in phthisis, produced by some force, which has exerted upon them a slow and very gradual compression, such as can only be conceived to have been produced by the accumulation of tuberculous matter in contiguous cells, pressing upon the intervening plexuses."

Dr. Bennett says, in reference to the inflammatory nature of tubercle, "A moments' consideration will show that the whole description depends upon what is meant by inflammation. If by that term be understood pain, heat, redness and swelling, or the

presence of lymph and pus, then certainly tubercle is not inflammatory: if, on the other hand, we consider that the essential phenomenon of inflammation is an increased exudation of the blood-plasma, then tubercle must be regarded as an inflammatory product."

In hepatization we have granules and perfect cells; in tubercle we have granules and imperfect cells. Both these morbid products are formed by the exudation of blood-plasma. If it undergo transformations into perfect organisms, it constitutes what pathologists have called "the results of inflammation;" in others, different kinds of tumours. When these transformations are arrested, or rendered imperfect, they form tubercle or scrofulous deposits. The essential distinction between the products of inflammation and tubercle must be sought for in a difference of composition (chemical and vital,) in the blood-plasma, of which they are each composed.

Both Mr. Rainey and Mr. Queckett mention having found distinct masses of white granular matter in the capillaries of scrofulous subjects, and in some cases have pressed strumous matter out from an artery going to a diseased part.

3. *What are the earliest Physical Signs of Tubercles in the Lungs?*—From what has been previously stated, the true pathological condition of the earliest stage of tubercle will be—first, several of the air-cells of the lung are rendered impermeable to the blood and air by the slow deposition of tubercular matter, which, accumulating in contiguous cells, presses upon the intervening plexuses; secondly, the blood is thrown upon the surrounding unaffected parts. This is well represented in drawing No. 6, Plate 3. Consequently, we sometimes find, in the earliest stage, a little bulging-out of that portion of the chest first attacked, usually the clavicular and subclavian regions, with a want of power in the respiratory murmur at the apex of the lung, the expiratory sound being louder, harsher, and rougher, than the inspiratory; and this is not removed by a full inspiration and coughing, as the comparison of the two sides will prove.

This bulging-out, however, soon disappears; and the apex, gradually losing the natural quantity of air in the cells, and fibro-cellular adhesions taking place, becomes subject to atmospheric

pressure, and then a flattening of the sub-clavian region is observed, and it sounds less resonant on percussion.*

These first signs are generally as well or more marked over the supra-spinal fossa and the top of the inter-scapular region behind, as they are in front; but it requires the patient to be placed in a position to separate the scapulæ widely from each other to discover them, and the percussion should be made with some force. This not being attended to, these signs are often overlooked until too late to check their progress.

Sometimes there is a general sub-mucous or sub-crepitant rhonchus; but this proceeds less from the tubercles themselves than from their irritating the adjoining bronchial tubes. It is a sign of bronchitis, and should only be taken as an evidence of tubercles when it continues permanent, and does not become sibilant and pass off as in the rhonchi of bronchitis.

In doubtful cases, the patient should be made to breathe very fully and freely; percussion should be compared at the end of both a full inspiration as well as expiration, and the percussion should be made, at first, very slightly, and increased in degree if necessary. On inspecting and feeling the infra-clavicular regions before a good light, the upper ribs of the affected side will be observed not to move so freely in inspiration as those of the sound side.

When the partial indurations are accompanied by a dilated or emphysematous state of the neighbouring air-cells, the sound on percussion will be less altered than usual; but the breathing will be more whiffing or more obscure, according as the dilated cells are more flaccid or more rigid than usual.

The voice-sounds are very peculiar. At first there may only be a diffused resonance; but this increases, so that at length quite a little voice is heard under the clavicle, without the articulation of the oral voice. The sounds are also transmitted from the neighbouring arteries and the heart very clearly to the ear, and sometimes these are accompanied by a whizzing or blowing. There is also a diminution of the natural vibration in the chest caused by the voice.

In the angle formed between the humeral end of the clavicle and the scapula will generally be found the most unequivocal

* See Plate 4, Fig. 8.

signs of tuberculous deposit; but it is best ascertained by comparison with the sound side. Here bronchophony and bronchial respiration are heard in perfection.

Dr. Latham notices a gentle bellows-murmur coincident with the systole of the heart only in a space on the left side of the chest, from the sternum between the upper edge of the second costal cartilage, extending an inch on the second rib and the lower edge of the third cartilage and rib, which he has for a length of time heard in consumptive patients only; and he lays so much stress upon this sound as to say, "Where, from my direct examination of the lungs, I cannot get beyond a suspicion of tubercular disease, the murmur in the space indicated must always contribute to confirm it." He supposes it may arise from the first division of the pulmonary artery, impeded in its motion by pressure from diseased lung.

Dr. Walshe, Sir James Clarke, and MM. Barth and Roger, particularly notice a peculiar kind of respiration, which they term "jerking respiration," as one of the earliest signs of phthisis, which is most perceptible during inspiration. Dr. Stokes thinks this sympton can be removed by treatment; but the former authors say it is quite persistent and pathognomonic. It most probably depends upon the obstruction thrown in the way of pulmonary expansion by the adhesions which so frequently form about the tuberculized apices of the lungs. This was the only distinct sign for a length of time in a case now under my own treatment, which latterly has too fully proved the correctness of its indication.

M. Fournet alludes to a grazing and crumpling breath-sound at the apices of the lung, frequently occurring in the first stage of tubercular deposit; but which, being occasioned by slight pleurisy, is not persistent.

As grey becomes converted into yellow tubercle, the disease advances, and the signs are more significant; the consolidation is greater, and therefore the chest sounds flatter on percussion; the natural breath-sound becomes more obscure or more bronchial, with louder expiratory murmur, and a fine bubbling or crepitation is heard.

About this period, if the expectoration be closely watched, some portions of air-cells, filled with granular tubercular matter, may be detected under the microscope, which gives evidence too decisive to be mistaken.*

* See Plate 3, Fig. 5.

After the tubercular matter begins to soften, we hear, under one of the clavicles, or above the spine of one scapula, a coarser clicking or bubbling in the breath-sound and cough, which eventually runs into complete gurgling or cavernous rhonchus.

When a vomica is formed, cavernous respiration and pectoriloquy become the pathognomonic signs. Should the cavern be very large and empty, amphoric blowing and metallic tinkling, or tinkling echo, may be heard, the parts all around being very dull on percussion; whereas, in pneumothorax, some part of the chest must have an unnaturally clear sound.

As the disease advances there is a very remarkable difference between one side of the chest and the other; a sinking of the walls under the clavicle of the affected side; a defect in its motion ascertained by the chest-measurer; and deficiency in its measurement ascertained by the tape.

The vital capacity of the chest, taken by the spirometer, will give most decided proof of loss of space for respiration. Mr. Hutchinson gives cases where the healthy vital capacity was 237 cubic inches, and only 60 in the advanced stages of phthisis. I have watched many such cases through a long course of treatment, and found the vital capacity gradually decrease as the disease increased.

The degree of expansion of the chest on inspiration, taken by a tape, will be found to decrease gradually from three and a half or four inches to scarcely half an inch; and the weight of the body will always decrease so long as tubercular disease is active in the lungs. As soon as a check is put to its progress, it will remain stationary, but the weight is hardly ever found to increase; whereas, in all other diseases of the chest, as soon as their progress is stopped, the weight of the body increases.

As the disease increases, the secretion of bile becomes vitiated; the carbon and hydrogen which ought to be exhaled from the lungs is, as it were, taken up by the capillaries of the liver, and deposited in the form of fat. The liver becomes congested, loses its natural red tint, assumes a pale fawn colour, and becomes softened, and is at last so loaded with fat as even to be termed "fatty liver." The kidneys also assist in carrying off the carbon and hydrogen, as well as the nitrogen, of the increasingly quick metamorphosis of tissue; and, in the later stages, very large

quantities of urate of ammonia, and, towards the end, uric and hippuric acids are deposited. When the contents of the vomicæ are not easily expectorated, the pus becomes absorbed, and pus-globules may be seen under the microscope in the urine.

Hæmoptysis is so frequently an early symptom of phthisis, and depends so entirely for its cause on tubercular deposit in the air-cells, as to demand a few moments attention.

The disposition to pulmonary hæmorrhage is increased by whatever tends to diminish the capacity of the thorax and to compress the lungs, heart, and great vessels.

Dr. Watson says, "It is a melancholy truth that the hæmorrhage which takes place by exhalation from the mucous membrane of the air-passages, is dependent, in a very large proportion of instances, upon incurable disease; and the complaint of which hæmoptysis is by far the most frequently symptomatic, is tubercular phthisis. I have long arrived at this conclusion, that if, from any given number of persons who have been known to spit blood, we subtract those in whom that symptom was connected with irregularity in the uterine functions, there will remain but few in whom the hæmoptysis did not depend upon disease, incurable and progressive in its nature, of the lungs or of the heart; and if we still further subtract those persons in whom the hæmorrhage was symptomatic of cardiac disease, there will be very few, indeed, left in whose lungs the existence of tubercles may not be confidently predicted." Klein says, "*Hæreditaria omnium pessima nec curanda nisi cum precautione hæmoptoes.*"

M. Louis found in eighty-seven cases of consumption, fifty-seven, or four in every six, who had hæmoptysis. In the experience of Andral, one in six never had hæmoptysis; three in six were attacked with it in the course of the disease; and two in six had it at the commencement. Excluding cases of amenorrhœa, and of mechanical injury to the thorax, Louis did not meet with a single example of hæmoptysis among 1,200 patients, except in such as were phthisical.

A very interesting and instructive question arises,—From what vessel does the blood flow in phthisical hæmoptysis? We have the large pulmonary arteries carrying the blood which is to be aerated, and the small bronchial arteries carrying the blood which supports and repairs the pulmonary membrane. The capillaries

of the pulmonary arteries are distributed round the air-cells, and carry venous blood; but the capillaries of the bronchial arteries are distributed to the mucous membrane of the bronchi, and carry arterial blood.

Inject the bronchial arteries with as much care as you possibly can, and you cannot, by so doing, inject the vessels which ramify on the air-cells; nor can you, on the other hand, inject the vessels which are distributed to the mucous membrane of the bronchial tubes from the pulmonary arteries.

Pulmonary hæmorrhage may, therefore, be divided into that which comes from the pulmonary arteries, which is black blood, and that which arises from the bronchial, which is scarlet blood; and these will be found to be distinct, not only in their pathology, but also in their characters and symptoms.

When the pulmonary artery bleeds, the blood oozes or escapes from its ultimate ramifications into the air-cells and the cellular tissue which connects them. That portion which exudes into the air-cells may get, through the intercellular passages, into the bronchial tubes, and be coughed up in the form of a black coagulum; but that portion which is extravasated into the intervesicular cellular tissue, has no such exit—there it must remain; it becomes coagulated and solidified: the air-cells at length become so clogged up and pressed together with this effusion, that pulmonary apoplexy is the consequence. The blood is clotted, effused in very large quantities, dark coloured, and contains very few air-bubbles: from such hæmorrhage very few, if any, phthisical patients recover. When a recovery does take place, it is in consequence of a coagulum forming, which, by its pressure, checks the bleeding, and the serum being absorbed, leaves a clot which eventually becomes organized. Dr. Addison relates cases of this description.

But in hæmoptysis from the bronchial arteries the blood is generally scanty, of a bright red colour, full of air-bubbles, and is seldom in such quantities as to be immediately dangerous: this is the most common form of hæmoptysis attending phthisis. The air-cells appear to be more protected from engorgement than the bronchial membrane; were it not so, tubercular phthisis would always be a very rapid and immediately fatal disease.

Hæmoptysis is always the consequence, and not the cause, of

tubercles in the lungs. The tubercular deposit consolidates part of the lung; and the blood, both from the pulmonary and bronchial arteries, not being distributed over that part as in health, is sent in greater quantity to the neighbouriug lobules, until the vessels become too full. Hæmoptysis occurs more frequently in the early than the later stages of phthisis; because, in the former, the natural quantity of blood is not diminished by hectic fever, diarrhœa, and loss of nutrition, as it is in the latter.*

The plan recommended by Dr. Osborne of applying half a dozen leeches every six hours to the hollow of the neck, just above the sternum, by keeping up a constant oozing of blood, is very efficacious in checking hæmoptysis; and gallic acid has been found to succeed when acetate of lead failed.

In *Guy's Hospital Reports,* Dr. Addison has published an admirable and invaluable Essay, where he proves, by numerous cases and specimens, that pneumonia is so closely allied to phthisis as to often elude the most experienced, cautious, and scientific practitioners. He very clearly divides phthisis into three classes, viz., pneumo-phthisis, tuberculo-pneumonic phthisis, and tubercular phthisis; and confidently asserts "that inflammation constitutes the great instrument of destruction in every form of phthisis." He says, "However analogous and closely allied the abnormal nutrition which produces tubercle may be to that which constitutes inflammation, we cannot admit their identity; nevertheless, pulmonary tubercles and the ordinary effects of inflammation have been confounded with one another." The sthenic or grey tubercle may, by deterioration, assume the character of the asthenic or yellow, but not the converse; the uniform tendency of all tubercles being retrograde, or towards loss of cohesion and disintegration.

Dr. Latham also discriminates phthisis by its being mixed or unmixed with inflammation, which the physical as well as general signs easily distinguish; and he says, the mixed kind is much more rapidly fatal,—is, in fact, galloping consumption.

Louis, the great authority for statistics in consumption, must

* The drawing No. 12, (exhibited when this paper was read,) shows an unusual case of hæmoptysis. A large tubercular cavity has, by ulceration, perforated one of the large bronchial tubes, and a branch of the pulmonary artery. Such a source of hæmorrhage admits of no relief.

certainly be in error respecting the inflammatory nature of the disease; for he affirms that neither bronchitis, pneumonia, nor pleurisy, have any effect in exciting tubercular phthisis. There are so many high authorities in our own country opposed to this opinion, that we cannot doubt the correctness of their conclusions.

Dr. Addison contends that, in most cases of phthisis, it is found, on inquiry, that the patient has previously been the subject of sub-acute inflammation of either the lungs or pleura; and the evidence after death consists in thickenings and adhesions of the pleuræ, with induration and puckering of the pulmonary tissue immediately surrounding each albuminous deposit; or, when the deposit is irregular and extensive, an actual deformity and puckering of the pleuræ above the infiltrated parts are generally found. See Fig. 8, Plate 4.

Instead of considering this appearance as the evidence of tubercular deposit, as it has hitherto been pronounced, he distinctly traces this condition from the termination of inflammation to the commencement of tubercular deposit, and says, "Pneumonia and inflammatory tubercle are identical. Such indurations of the pulmonary tissue, altogether independent of tubercle, are, I am more and more persuaded, of very common occurrence; and, moreover, venture to predict that the time is not far distant when it will be generally acknowledged that they have not, by any means, commanded the attention they deserve."

But whether they occur in tuberculated lungs, or in lungs unoccupied by tubercles, they have the same origin; they are the result of pulmonic inflammation, they present the same changes in their progress to permanent induration or repair, and manifest the same tendency to retrograde or disorganize at various periods of their existence, according to the state of the patient's constitution; or, under the influence of certain morbific causes acting more immediately upon the lungs themselves, they may soften down or even form sloughs at a very early period of their development or formation, or, after an indefinite period, begin to disintegrate and give rise to excavation, with most of the ordinary signs and symptoms of phthisis; and, as Dr. Addison very forcibly remarks, the physical signs, feebleness or absence of respiratory murmur, bronchophony, tubular respiration and dulness on percussion, are more the results of inflammation than the extension of

tubercles in pneumonic phthisis, and may occur without a tubercle being in the lung at all. See Plate 1, Fig. 2, and Plate 4, Fig. 7.

After having endeavoured to set forth clearly those physical signs which may be considered pathognomonic of tubercular disease in the chest, we will turn to the adverse side of this subject; and, by giving the opinions of Drs. Williams, Stokes, Addison, and Hughes, direct some attention to the rocks and shoals which render this coast so difficult to steer safely through.

"Of all the sources of fallacy to be encountered in the physical diagnosis of diseases of the lungs, bronchitis is by far the most prolific of mistakes and oversights; it may greatly obscure phthisis, pneumonia, and pleurisy, as well as divers forms of chronic disease of these organs." It may obscure dulness of percussion, tubular respiration, and even bronchophony or pectoriloquy, particularly in the early stages, where it is of such consequence to make a clear diagnosis, the difficulty being then increased by the absence of any flattening or immobility of the ribs. The more limited the bronchitis, especially if seated at the apex, the greater the probability of its being associated with phthisis; the more general the bronchitis, especially if it affect both lungs, the greater the hope of an exemption from this disease. The more abrupt the transition from bronchial obstruction to natural or puerile respiratory murmur in the affected part of a lung, the greater the likelihood of phthisis. The general tendency of bronchitis is to *enlarge,* that of phthisis to *contract,* the chest.

When with bronchitic rhonchi there is dulness on percussion, tubular respiration, bronchophony, pectoriloquy and gurgling, it may be the result of changes produced by a former pleurisy, pleuro-pneumonia, or pertussis, and not phthisis.

If the larynx be involved, the sounds of the chest are so altered by the sonorous râle, that it requires great caution in giving an opinion.

It is well known that the communication between an empty phthisical cavity and the bronchi may be temporarily obstructed by adhesive secretion; and if the cavity be large and superficial, the resonance may be so good as to deceive. This state requires strict examination after free coughing.

A long tickling uvula may produce all the symptoms of phthisis, except the physical signs.

When any form of chronic induration of the pulmonary tissue exists, and especially if attended with dilated bronchial tubes, neither auscultation nor percussion enables us to distinguish such a condition of the lung from phthisical disease. If the consolidation occurs at the apex of the lung from pneumonia, even without any considerable bronchial dilatation, there is the greatest difficulty in diagnosis; and, if accompanied by excess of mucous secretion in the bronchi, the almost certainty of suspecting it to be disorganizing phthisis.

A bronchitic râle, confined to the upper lobe of one or both lungs, resisting treatment, and accompanied or followed by dulness, at first slight, but gradually increasing, are as valuable physical signs of phthisis as any we possess.

Drs. Stokes, Forbes, Watson, and Williams, consider pectoriloquy alone a very vague sign of phthisis. Cavernous respiration is a much more alarming sound. Whenever pectoriloquy is heard in consequence of a cavern, there will be heard also cavernous respiration; but the converse is not necessarily the case. A splashing sound on coughing is frequently more decisive of a cavity than any other.

When, during the rapid progress of phthisis, a violent pain in the side, and extreme dyspnœa and anxiety set in suddenly, they denote, with much certainty, perforation of the pleura and its serious consequences, pneumo-thorax, &c.

Dr. Watson remarks that ulceration of the trachea is seldom revealed by any symptom, although patients are continually persuaded by medical practitioners, who know no better, that their symptoms are either "all tracheal" or "all stomach."

The metallic character or tinkling may be given to every physical phenomenon of the chest, from simple distension of the stomach and intestines with air. All the râles, from the finest crepitus to gurgling, as well as the vocal phenomena, such as pectoriloquism, bronchophony, and ægophony, may become metallic under these circumstances. The friction-sounds of pleurisy and pericarditis, and the sounds of the heart, are liable to this modification, which may deceive a practitioner unless he is guarded.

When we take into consideration these sources of error, against which even the accomplished stethoscopist is not universally nor altogether proof, and when to this we add the fact that a very

considerable proportion of the profession still, unfortunately, continue to disregard auscultation, or are unable to avail themselves fully of its advantages, we cannot be surprised that morbid changes, the result of a by-gone inflammation of the lungs, should fail to be recognized until it is too late for any treatment to be effective, or perhaps not even during life. How necessary must it be then, at the same time that we bring all the aid to bear which physical diagnosis can give us in such cases, that we do not forget to recognize the actions and sufferings of the constitution at large which precede and attend them. And although general symptoms have been purposely omitted in this rough sketch of chest diseases, it has not been because they are lightly considered; for the greatest error which can be committed with regard to auscultation, is to attach too great importance to it, and to esteem it a science of itself, independent of the general symptoms and history of disease.

4. *Can any mode of Treatment be adopted to prevent its ravages?*—Tubercular phthisis is too well known to be considered exclusively a pulmonary disease; but, unfortunately, the want of more success in the treatment of it has induced a very general belief in the minds of medical practitioners as well as the public, that a perfect cure is not attainable; palliation of the symptoms has, therefore, become the principal indication. The following facts tend to show that such a position is untenable.

Cicatrices, with cretaceous or calcareous concretions, are very commonly found at the apices of the lungs in *post-mortem* examinations. See Plate 4.

In four months Dr. Bennett, of Edinburgh, examined seventy-three bodies: in twenty-eight, puckerings and concretions were found. In two years and a half he examined 500 bodies, and very rarely missed finding puckerings and concretions at the apices of the lungs, either from pleurisy or tubercle.

In 100 bodies examined by M. Rogée, at the Salpêtriere Hospital in Paris, these lesions were discovered in fifty-one; and in 135 examined by M. Boudet, they were found in 116.

Dr. Bennett says, "It may be well, before proceeding further, to determine whether the lesions now alluded to are really proofs of cured tubercular deposits of the lung." This seems to be established by the following facts recorded by him :—

"1st. A form of indurated and circumscribed tubercle is frequently met with, gritty to the feel, which, on being dried, closely resembles cretaceous concretions.

"2ndly. These concretions are found exactly in the same situation as tubercle.* Thus they are most common in the apex, and in both lungs; they frequently occur in the bronchial, mesenteric, and other lymphatic glands, psoæ muscles, or other textures which have been the seat of tubercular depositions or scrofulous abscesses.

"3rdly. When a lung is the seat of tubercular infiltration throughout, whilst recent tubercle occupies the inferior portion, and older tubercle, and, perhaps, caverns, the superior, the cretaceous and calcareous concretions will be found at the apex.

"4thly. A comparison of the opposite lung will frequently show, that whilst on one side there is a firm encysted tubercle, partly transformed into cretaceous matter, on the other, the transformation is perfect, and has occasionally even passed into a calcareous substance of stony hardness.

"5thly. The puckerings found without these concretions exactly resemble those in which they exist. Moreover, whilst puckering, with grey induration, may be found at the apex of one lung, a puckering surrounding a concretion, may be found in the apex of the other.

"6thly, and lastly. The seat of cicatrices admits of the same exceptions as the seat of tubercles. In one case I have found the puckering and cicatrix in the inferior lobe only, and have met with three cases where the inferior lobe was, throughout, densely infiltrated with tubercle, whilst the superior was only slightly affected.

"If further proof be required to convince us that these puckerings and concretions are really evidences of cured tubercle, it will be found in the circumstance, that since the days of Laennec, (by whom they were minutely described and figured,) no pathologist has called in question a fact which seems so well established.

"The observations of Rogée and Boudet, in Paris, confirmed as they are by my own of the Royal Infirmary of this city, will probably serve to establish that this spontaneous cure of tubercle has occurred in the proportion of from one-third to one-half of all the individuals who die after the age of 40.

* See Plate 4, Fig. 8.

"Tubercular disease of the lung, then, instead of being almost invariably fatal, as it is generally considered, not only heals spontaneously now and then, but is of very frequent occurrence."

Dr. Bennett says, "The tubercular exudation, when broken down and rendered molecular, is capable of being absorbed in the same manner as the product of healthy inflammation. But, as the rapidity of the molecular disintegration of exudation is dependent upon its power of growth, so this change must take place in tubercle more or less slowly, according to its organizable powers."

As there is nothing, then, in the nature of tubercle itself which opposes the anatomical evidences previously described, the fact of the frequent spontaneous cure of tubercle may be admitted. On looking over the works of our greatest authorities on this subject, I find that the occasional curability of the disease is admitted by all. Laennec, Andral, Cruveilhier, Kingston, Pressat, Rogée, Boudet, and many others, have published cases where all the functional symptoms and physical signs of the disease, even in its most advanced stage, were present; and yet, where the individuals survived many years, ultimately died of some other disorder, and, on dissection, puckerings and concretions have been found in the lungs. Rokitanski observes, that pulmonary phthisis is, without doubt, curable.

M. Boudet says, that in one year he met with fourteen cases where softening of tubercular matter in a cavern was evident, all traces of which subsequently disappeared. M. Rogée refers to many others. Dr. Stokes says, that in a few cases, even after excavation has formed, he has seen a recovery. For a confirmation of this point, indeed, I may safely refer to the experience of old practitioners, many of whom have described to me several cases where all the symptoms of phthisis were present which ultimately recovered. So deeply rooted, however, has been the opinion of the necessarily fatal nature of this disease, that, not being guided by auscultation, and simply because they recovered, it was concluded that the disease was not phthisis; that is, they have rather distrusted their own diagnosis than venture to oppose a dogma of universal belief.

Dr. Williams says, "Destructive as phthisical lesions are, both by their own tendencies and by the manner in which they affect the system; it is, nevertheless, well ascertained that they do occasionally admit of cure. I cannot bring morbid anatomy to prove

the probability of a cure in the earlier stages of phthisis; but I have the history of several cases in which the signs render it extremely probable that some of the depositions which form the first stage of consumption of the lungs had been removed by absorption. There has been cough, shortness of breath, hæmoptysis, pain under the clavicle, quick pulse, evening fever; and these symptoms, instead of taking the course of an ordinary cold, have remained permanent for two or three months, with loss of flesh and strength. On physical examination, there has been found dulness on percussion under the clavicles or supra-scapular ridges, bronchial respiration or a slight permanent rhonchus, and increased resonance of the voice. Under treatment and favourable climate, these symptoms and signs have been gradually removed; in some cases entirely. I maintain that, in these cases, the existence of phthisis was as much proved as it ever can be in its early stage; that precisely similar cases, when neglected, run a consumptive career; and we are not aware that such a combination of signs and symptoms can be produced but by lesions which essentially have a phthisical tendency."

The treatment of pulmonary consumption has, for the most part, been conducted on strictly empirical principles. One vaunted remedy has succeeded another; they have all been tried and found unsuccessful. The pathology of the disease readily explains this circumstance, as no one remedy can be useful in a disorder that, from its commencement to its termination, presents such different characters and indications. These characters and indications are only to be ascertained by a practised auscultator, and the signs which guide his practice are totally inapplicable to others who cannot distinguish them.

Rokitanski observes, "Researches into the circumstances under which a natural cure takes place, is the only method by which we may expect to arrive at a rational mode of treatment, as it must be directed, not against the pulmonary ulcerations, but against the general tuberculosis." Hence a knowledge of the progressive march of tubercular depositions towards a cure is of permanent importance, and would seem, from the observations of Dr. Bennett, to take place in the following manner:—

At first, tubercle is deposited in a fluid state from the capillaries, in the same manner as lymph. The miliary and infiltrated forms,

whether grey or yellow, after a time, soften—a process which may commence at any part of the mass, and gradually affect the whole.* We generally find that the parenchyma of the lung or the pleura in the immediate neighbourhood of such deposition, is more or less inflamed, indurated, and thickened. The pleura, especially, is almost always affected, and in such cases reaches a thickness and density unknown in other diseases.† The parenchyma is also rendered dense, and produces a thick indurated capsule all round the tuberculated deposit, which is frequently of semi-cartilaginous hardness, and so firm as to retain its form, even when the softened tubercle has been evacuated by expectoration through the bronchi. This gives rise to the dry blowing-sounds, often heard over such cavities. If the destruction of the organ be not carried to such an extent as to cause death, and if the further depositions of fresh tubercle can be checked, the cavern gradually contracts, its walls unite or close upon tubercle which has undergone transformations, and a cicatrix is formed.

If, then, the further deposition of tubercle could be arrested, there seems no reason why cavities in the lungs should not heal with the same frequency as ulcerations or abscesses in other internal organs. This is only to be accomplished by overcoming the pathological conditions on which the deposit of tubercle depends. These are, first, a morbid state of the blood, the result of imperfect nutrition; secondly, local inflammation, by means of which an unhealthy exudation is poured out that assumes the form of tubercular or scrofulous matter.

It is sufficient to say that chemical, morphological and physiological facts unite in pointing out that this is attributable, first, to an excess of oxygen in the system, which combines rapidly with the tissues to produce waste, and to occasion acidity in the alimentary canal; and, secondly, to an excess of nitrogenized or albuminous, and a deficiency of carbonized or oleaginous, matters in the chyle, blood, and tissues generally; the liver, the great emunctory of fatty and carbonized matter excepted.

I need not more especially allude to the fact, that all the local symptoms and physical signs are identical with those of inflammation; they only differ with respect to their more frequent situation at the apex instead of at the base of the lung.

* Plate 3, Fig. 5 and 6. † Plate 4, Fig. 8.

The indications for treatment, therefore, are, *first, to overcome the dyspepsia and acidity in the alimentary canal; secondly, to furnish the material necessary for the formation of a healthy chyme; and, thirdly, to combat the local inflammation.*

The principal difficulty in the treatment will be found to consist in removing, at the same time, general imperfect nutrition and debility, together with a local inflammation and irritability dependent on it. The dyspeptic symptoms frequently continue throughout the disease; they often become uncontrollable; and the extreme irritability of the mucous membranes is evinced by vomiting, diarrhœa, bronchorrhœa, and laryngitis.

The imperfect nutrition will be best overcome by an easily digestible and nutritious diet;—milk, substances abounding in oleaginous rather than albuminous principles, and an equable warm climate, whereby, in conjunction with the diet, the excess of oxygen in the system may be diminished. The boasted good effects of naphtha are attributable to its power of allaying the irritability of the stomach, and thus enabling the patient to take nourishment. In following the second indication, cod-liver oil, rectified, is a most valuable remedy.

The local inflammation must be combated by topical blood-letting, in the first stages, as leeches and cupping; in the later stages, by counter-irritation, especially stimulating embrocations, tartar-emetic ointment, blisters, and the moxa.

Experience will prove that whenever treatment has been beneficial in phthisis, it will be found to have occurred from its having, either by design or accident, been so directed as to meet the pathological conditions pointed out. One thing, at least, is certain, that they can never be overcome by a blind adherence to one particular remedy.

Whatever opinions may be held with respect to the value of the indications and treatment proposed, it will, perhaps, be conceded that the facts now brought forward are sufficiently important to warrant renewed trials, directed to the curative, rather than the mere palliative treatment, which is now so very prevalent.

In carrying out the first indication named above, it is of the utmost importance that patients should reside in a climate which is sufficiently and equally warm and dry, so that too much oxygen

cannot be inhaled. I believe, from personal observation and the most accurate accounts published, that Torquay is the best winter as well as summer residence in this country.

In a pamphlet lately published by Mr. Vivian, "On the Climate of Torquay," the following facts are proved by a comparison of the statistics of Torquay with Penzance, Undercliffe, Bath, Hastings, Newport, (Isle of Wight,) and other places, and the errors previously made by Sir James Clarke and Dr. Granville, very clearly set forth:—

The mean annual temperature is higher than at any other place in Great Britain or Ireland. This advantage is felt in the cold months; the summers being cooler than at most other places in about the same proportion that the winters are warmer; the climate is, therefore, more equable. During the quarter ending June, 1846, the temperature of Bath was fourteen degrees higher and twelve degrees lower than Torquay; the difference of range between the two places being twenty-six degrees in favour of Torquay.

The number of days upon which rain falls is less in Torquay than in any other place in England; and the total amount is sixteen inches less than at Penzance, and four inches less than at Clifton. It possesses a dry air, exceeding Bristol and Clifton by three degrees. The east wind is here a sea-breeze, an advantage peculiar to this coast. The mean annual mortality is only one in sixty-one, whilst in Devon it is one in fifty-three, and in England and Wales one in forty-five. It is warmer in winter and cooler in summer than Clifton and Hastings by from two to five degrees.

An overland wind is heated in summer by the radiation from an arid soil, and chilled in winter by its passage over a frozen surface; the sea-breeze, on the contrary, is equable. The east and south-east winds, which are generally the hottest, are in Torquay a sea-breeze, giving it a great advantage over North Devon and the inland districts, which are frequently recommended as affording a cool summer residence. It is very certain that, practically, neither heat nor moisture are found in excess at Torquay; and now that the town extends almost to the summit of the surrounding hills, there is not a spot on the coast where so free a circulation of air and so cool a temperature can be enjoyed, or where diversities of aspect and luxuriance of foliage afford such refreshing shade, which

enable invalids to take exercise in the open air every day throughout the whole year. The nearest approach to the climate of Torquay is Cove, in the south of Ireland.

In attending to the second indication, those aliments should be avoided which tend to increase the supply of hydro-carbon to the blood, such as animal food abounding with fat, alcohol, &c.; and the principal meals should be made from lean meat, and other albuminous and fibrinous articles which contain kreatin and lactates, with farinacea and fruit abounding in vegetable acids, when the mucous membrane will bear them. The directions given by Liebig in his "Chemistry of Food," which time does not allow to quote, will be found very valuable in enabling us to supply sufficient nourishment to irritable stomachs.

Phthisical patients, who take a large quantity of cod-liver oil, almost invariably become stouter under its use, and some of them increase in weight, although the disease remains unchecked. It is doubtless a tonic and deobstruent, from containing iodine and bromine, and conveys nourishment to the system in such a form as not to excite. Can it supply hydro-carbon to the blood in a better form than other aliments do, so as to require less oxygen to keep up animal heat? Plencke attributes its usefulness to its supplying the deficiency of the fatty principles of the bile, which are not excreted in sufficient quantity, but remain in the organ, constituting the fatty liver.

It is now ascertained that cod-liver oil, free from taste, colour, and smell, purified by animal charcoal, and deprived of its stearin by cooling and filtration, is the most effectual form for administration, as in this state it possesses a solvent power over the fat of tubercular deposits; and, probably, Dr. H. Bennett, and Dr. C. J. B. Williams, are correct in their opinions as to its mode of action. They say, that as the nuclei or rudimental molecules of all structures appear to consist of fat, this oil, in its highly divisible state, readily supplies and renews them. It also penetrates into imperfectly organized deposits, (cacoplastic and aplastic,) softens their concrete fatty molecules, and brings them more under the influence of the adjoining living parts through the circulation,* by which either their vitality and nutrition are improved and maintained; or, if incapable of improvement, are gradually dissolved

* Plate 3, Fig, 6.

and absorbed away. There can now be no doubt entertained of the real efficacy of this substance, properly administered, in improving most cases of scrofulous disease, by its marked influence on nutrition.

Frequent friction over the chest with some slightly stimulating liniment, so as to keep the circulation in the skin active, and warmth applied to the extremities, tend to promote the gradual solution of the deposits, by directing the oxidating current of arterial blood through the affected parts. The occasional administration of small doses of chlorate of potass with sarsaparilla, nitric or nitro-muriatic acid, iodide of potassium with various preparations of iron and liquor potassæ, are, doubtless, very frequently of the greatest advantage, and act much in the same manner, by supplying oxygen to the tissues through the capillaries.

After evident physical and other signs of the existence of a tubercular cavity, contraction of that part of the chest in connection with it ought to be considered a favourable sign, as it indicates a certain degree of constitutional power and attempt at repair. This state will be easily distinguished from increase of consolidation, caused by fresh deposition of tubercular matter, by carefully watching the progress of the symptoms and signs; and whenever it does take place, ought to encourage us to persevere in such treatment as will tend to prevent fresh deposition of tubercle, and maintain the tone of the system.

I take this opportunity of acknowledging my great obligation to my friend, Dr. Branson, of Sheffield, through whose talent, industry, and obliging and agreeable disposition, I have been enabled to illustrate many parts of this paper with well executed drawings; and I am also much indebted to my son and Mr. Tuson, of University College, for the injections and microscopic drawings.

I intimated in the beginning my intention of noticing diseases of the heart; but too much of the valuable time of the Association has already been occupied. Were it not for the regard which we must all feel towards those of our fellow creatures,

> "The fairest of Creation, last and best
> Of all God's works,"

who are, by consumption, sent to their early grave, I should think

it indispensable not to conclude without apologizing deeply for having dwelt so long on the last sad subject. But I consider

> "That which before us lies in daily life
> Is the prime wisdom:"

and, however imperfect the observations, and incompetent their author may be, there must be many present who, in consequence of the imperfection of our knowledge, have deeply mourned the loss of valued friends; and they, at least, will pardon him for endeavouring to arrest the attention of the meeting on this perplexing but deeply interesting subject.

The difficulties which have been overcome by the improved methods of detecting diseases of the chest during the last twenty years, and the gradually increasing knowledge in all the collateral sciences, hold out a hope that consumption—by which disease even long-departed Sydenham declared the fifth part of mankind fell—may yet be cured.

Galileo and Leuwenhoek might with equal justice have given up all hope of exploring beyond the scanty realm of their attainments, before those wonderful instruments had been wielded by them, which since their distant age has revealed, on the one hand, worlds, whose portentous dimensions and majesty of economy have equalled, on the other, the exquisite beauty which pervades the organism of the monads of our aqueous drop.

When we consider, on reviewing the past ages of observation and research, that their result has, invariably, been to unfold the links in the vast but connected chain of nature, which before the mist of ignorance bedimmed, have we not the right to expect that, at some future day, we shall behold the vast regions cleared which now so deeply disconnect the endless transitions of creative nature?

We have though, as yet, viewed the works of God in their normal or prevailing condition: may we not expect the same transitions to exist—the same end to be hoped for—in their unhealthy, abnormal phenomena, as in their healthy ones? Are these the products of a different law?—the offspring of a distinct nature? Let us, then, be cheered with the result of the science of the past, stimulated by the onward goal of future good!

In these our labours, even a higher privilege awaits us than the noble alleviation we claim as our sole reward: interweaved at its every step is the finger of the Almighty!—the impress of his

genius! Our own wished-for aim is the prolongation of our short earthly life; incorporated with our very labours to effect this purpose is the evidence of our adaptation for a better!

May every vile attempt to libel our profession with the brand of infidelity be as futile as that ancient scandal on our great "Father of Medicine," in whose beautifully pious words I hope to be allowed to conclude:—

"Καὶ γὰρ αὐτέοισιν ἐκείνοισιν, οὕτω δ'οὐκ οἴονται ὁμολογέουσιν ὧδε, τὰ περὶ σώματα παραγενόμενα ἃ δὴ διὰ πάσης αὐτῆς πεπόρευται, μετασχηματιζόμενα ἢ μεταποιούμενα, ἃ δὲ μετὰ χειρουργιήν ἰώμενα, ἃ δὲ βοηθούμενα, θεραπευόμενα ἢ διαιτώμενα· τὸ δὲ κεφαλαιωδέστατον ἔστω εἰς τὴν τοιουτέων εἴδησιν."—

Ιπποκρατους περι ευσχημοσυνης.

EXPLANATION OF THE PLATES.

PLATE I.

FIG. 1 represents a bronchial tube and its continuation, the intercellular passage. The capillaries of the pulmonary artery are injected. The lining *fibrous* membrane of the intercellular passages and air-cells is distinctly seen. This is represented as magnified twenty-seven diameters linear.

a. Oblique section of bronchial tube.

b. Capillary system of lung.

c. Air-cells opening into intercellular passage.

d. Ultimate ramifications of intercellular passage.

e. Air-cells.

g. Lining *mucous* membrane of bronchial tube.

FIG. 2.—A portion of lung affected with red hepatization, presenting appearances very commonly mistaken for tubercles softening in the centre.

This form of pneumonia very frequently lays the foundation for tubercular deposit, and then it is difficult to ascertain precisely where pneumonia terminates and phthisis begins.

The Plate is copied from a drawing the size of nature.

a. Red hepatization.

b. Bronchial tubes thickened, softened, dilated, and containing a muco-purulent fluid. Bristles are introduced into their truncated extremities.

PLATE II.

FIG. 3.—A section of bronchial tube ending in an intercellular passage, showing the lining *mucous* membrane of the bronchial tube.

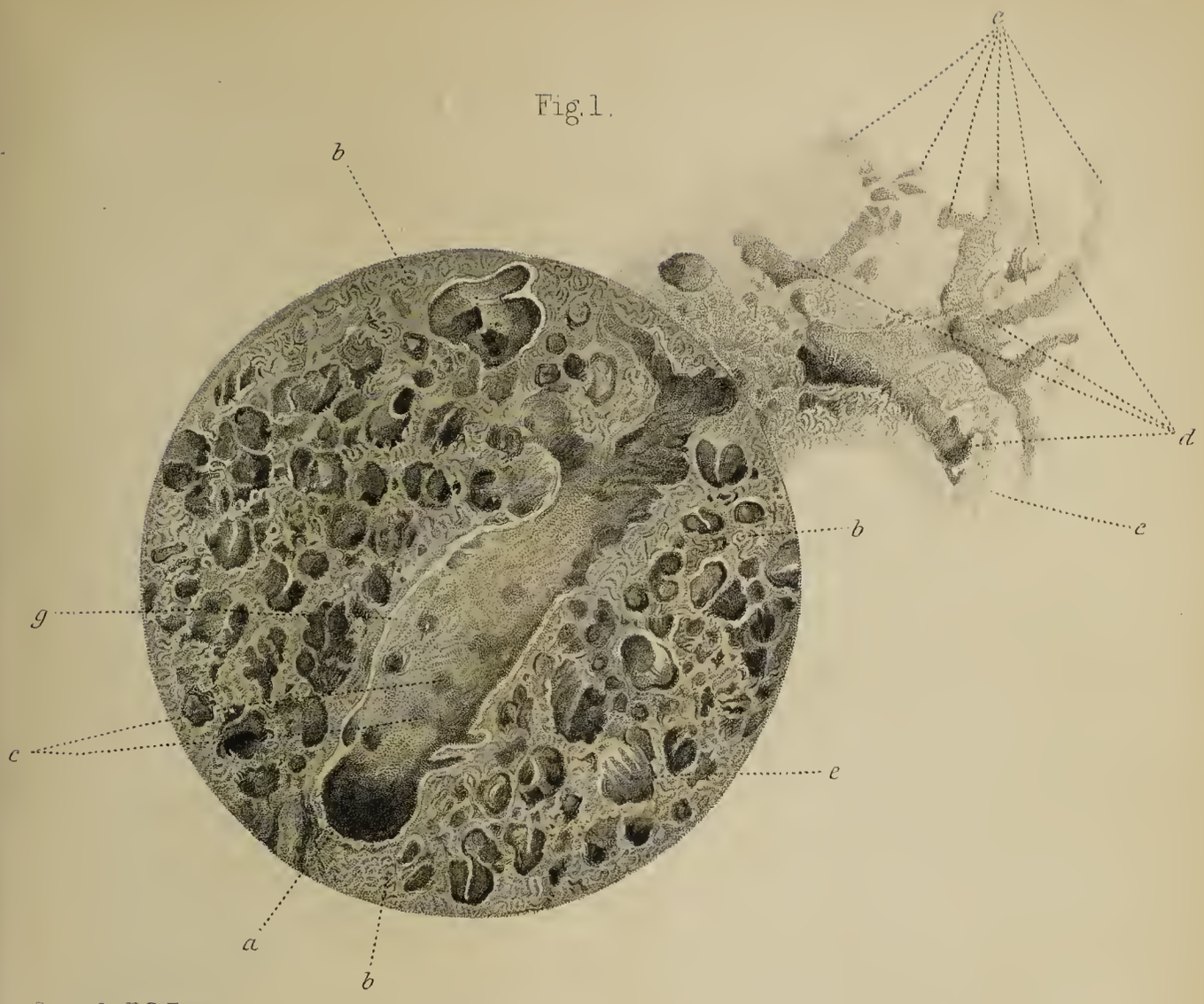
In this figure the capillary system round the air-cells is clearly delineated; and the connection between the nutritious arteries of the bronchial tube and the capillary system of the air-cells is quite distinct. Magnified fifty diameters linear.

a. Bronchial tube.

b. Capillary system of lung.

c. Termination of the *mucous* lining membrane of the bronchial tube.

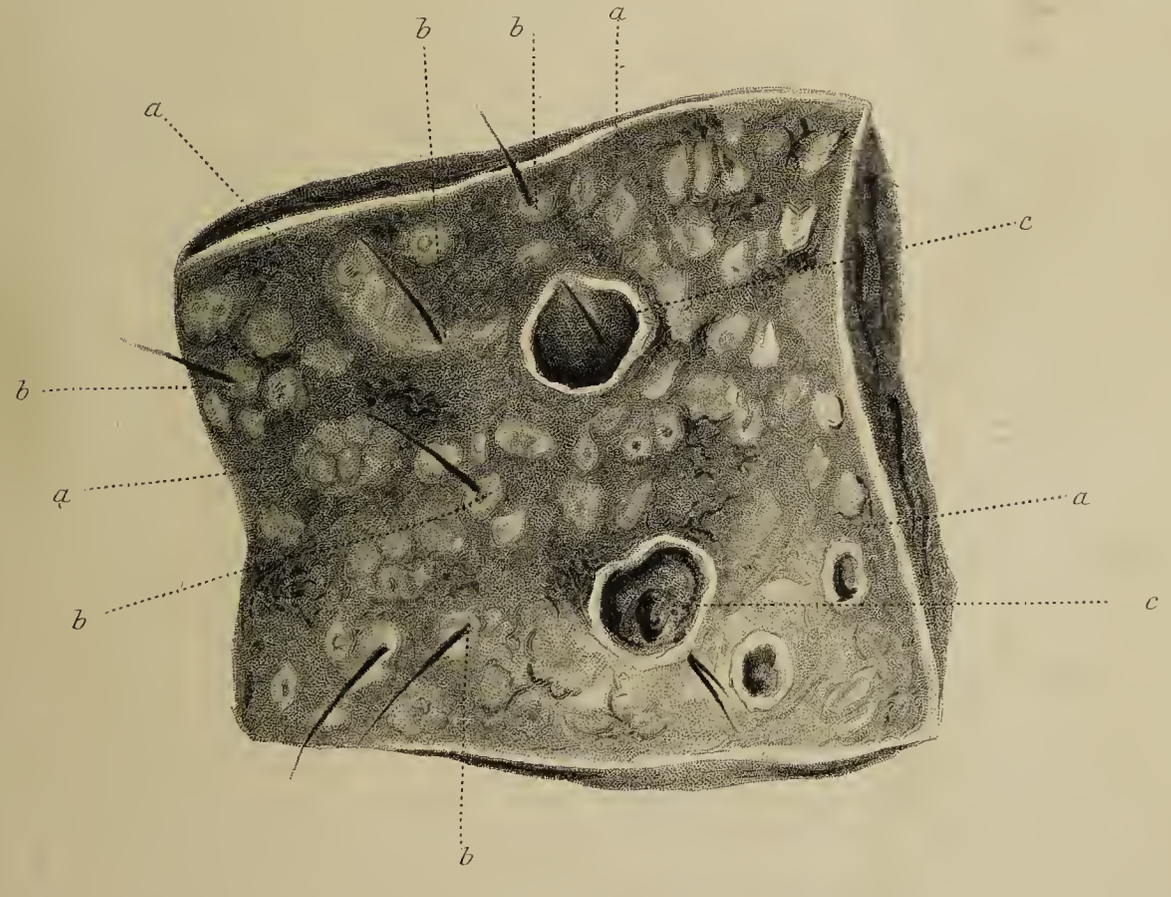
Fig. 1.



Drawn by H. B. Tuson.

Injected by C. J. Shearman, A.B.

Fig. 2.

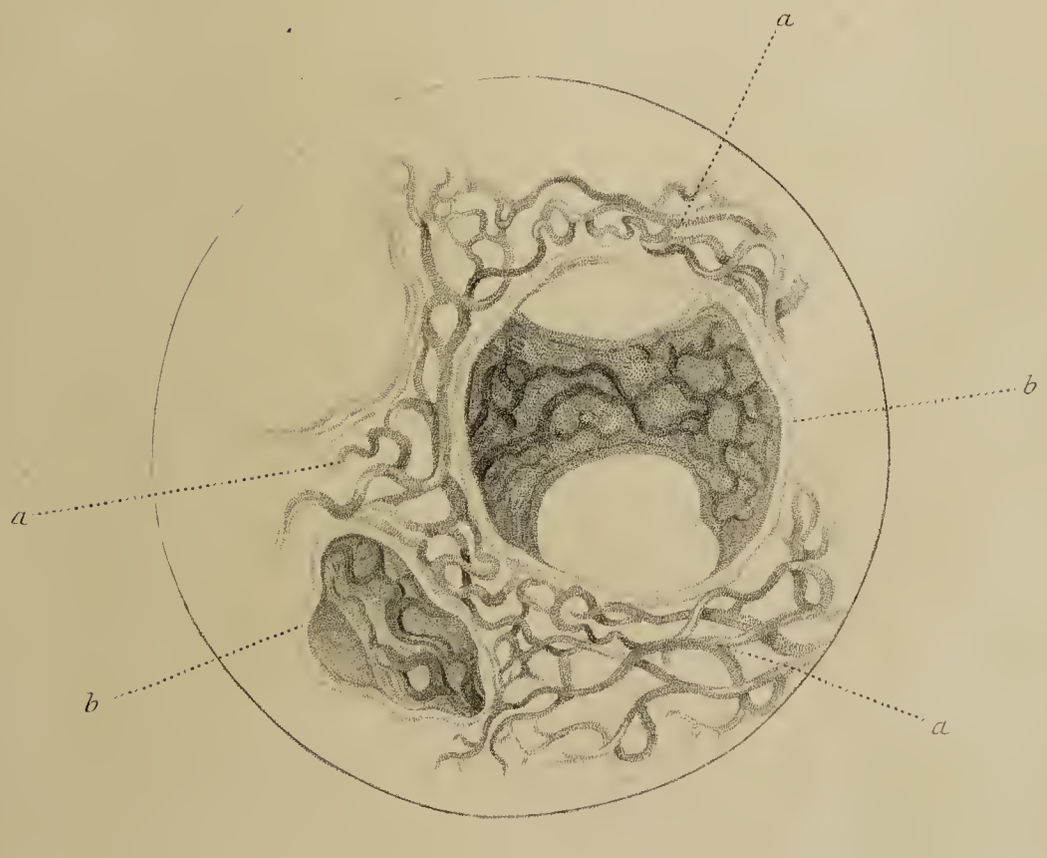


Drawn by D^r. Branson.

Engraved by H. Adlard.

Fig. 3.

Fig. 4.



Drawn by H. B. Tuson.

Injected by Mr Ramey.

Engraved by H. A. L. a. d.

Fig. 5.

Plate 3.

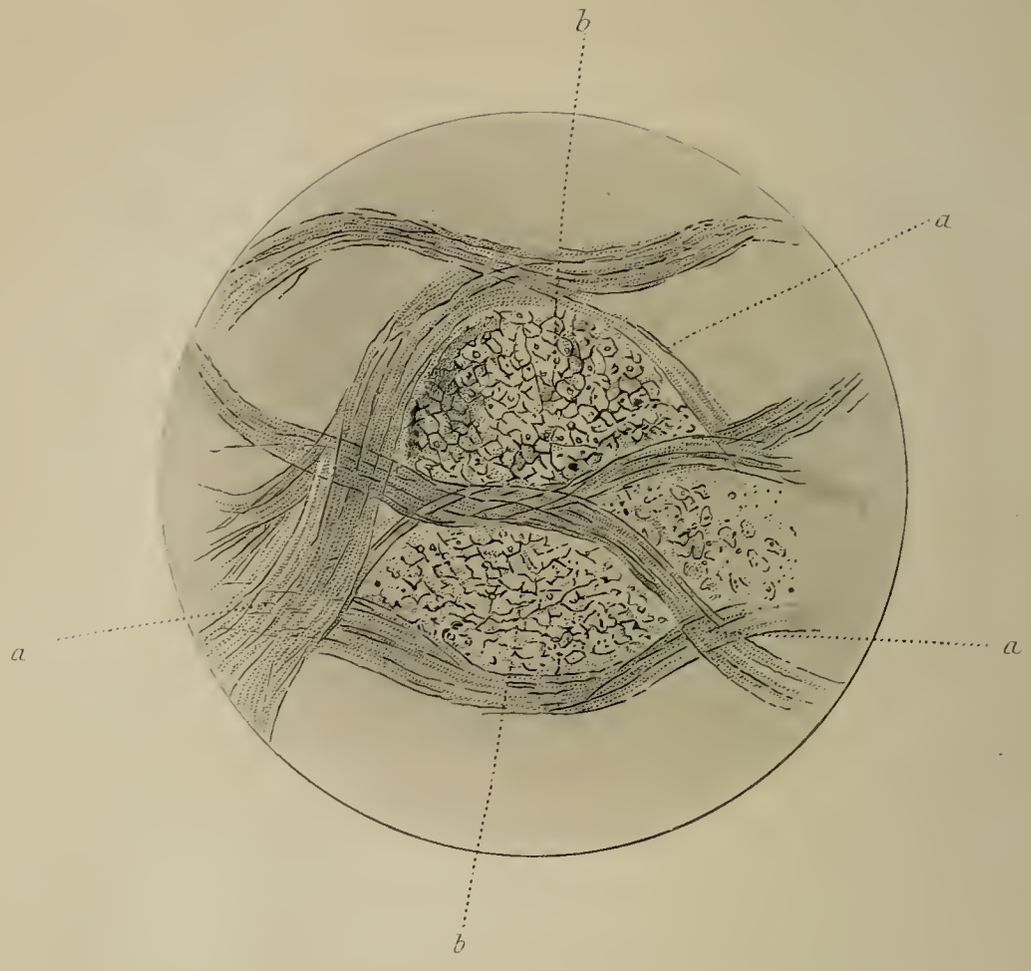
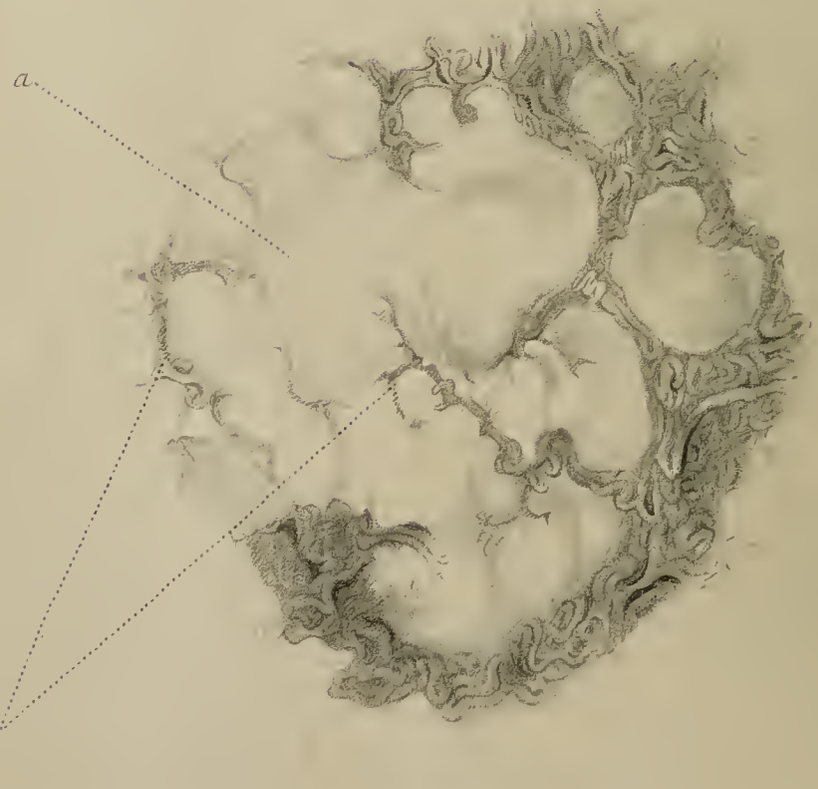


Fig. 6.



Injected by Mr Rainey.

Engraved by H. Adlard.

FIG. 4.—A highly-magnified portion of pulmonary membrane, inclosing the capillary plexuses, and exhibiting the *fibrous* lining membrane of the air-cells distinct from each other, with the capillary system between them.

a. The capillary plexuses.

b. The free margin of the lining membrane of the air-cells, and forming the immediate boundary of the opening of one air-cell into another.

PLATE III.

FIG. 5.—Microscopic view of tubercular deposit in the air-cells. Magnified 250 diameters linear.

a. Filamentous tissue of lung.

b. Dense granular matter occupying the air-cells.

FIG. 6.—Section of tuberculous deposit in an injected lung, showing that the gradual deposition of tubercular matter presses on, and finally obliterates the capillary vessels. Magnified 250 diameters.

a. Tubercular matter.

b. Remains of capillary vessels.

PLATE IV.

FIG. 7.—A section of lung representing tubercles surrounded by the effect of old and recent pulmonic inflammation.

The Plate is half the size of nature.

a. Tubercles surrounded by iron-grey induration from ancient pulmonic inflammation.

b. Red hepatization from recent pulmonic inflammation.

The apex of the lung has been extensively disorganized by tuberculo-pneumonic phthisis; a form of phthisis in which disorganization results partly from the softening of recent hepatization, and partly from the disintegration of pneumonic indurations more or less ancient.

Dr. Addison, who has kindly allowed me to copy this Plate, remarks, "Although rude and incorrect, some sort of analogy may be drawn between sthenic tubercles in the lungs and acne on the face. The follicles in the latter, although large and distended, may remain perfectly quiescent, and without producing the least inconvenience; so may tubercle in the pulmonary tissue. Inflammation may be set up in the distended follicle; so it may be in the pulmonary nidus of tubercle. The inflammation of the follicle may not proceed to suppuration, but terminate in an earlier adhesive process; the same may take place in the pulmonary nidus of tubercle, leading, as it commonly does, to iron-grey induration immediately around. The

follicle may suppurate; so may the nidus of tubercle. The inflammation may extend considerably beyond the boundary of the follicle; the same happens with tubercle: nay, in some forms of acne, the intervening skin occasionally inflames primarily; thus, still bearing some analogy to the inflammatory complication so constantly observed in phthisis." My experience perfectly confirms these very sensible remarks.

Fig. 8.—Section of lung, showing contraction and puckering of the pleura and surface of the lung, with granular induration and deposit, little inclined to become organizable—simulating phthisis.

a. Old albuminons deposit on the pleura, with contraction and puckering of the pleura and surface of the lung.

b. Section of granular induration or deposit in the cells, discoloured by interposed black pulmonary matter.

This is represented half the size of nature.

I beg to acknowledge my obligations to Mr. Henry Adlard, for having executed these Plates in so able a manner as to convey to the reader an impression equal to that given by the coloured drawings.

Rotherham,
August 5th, 1848.

Fig. 7.

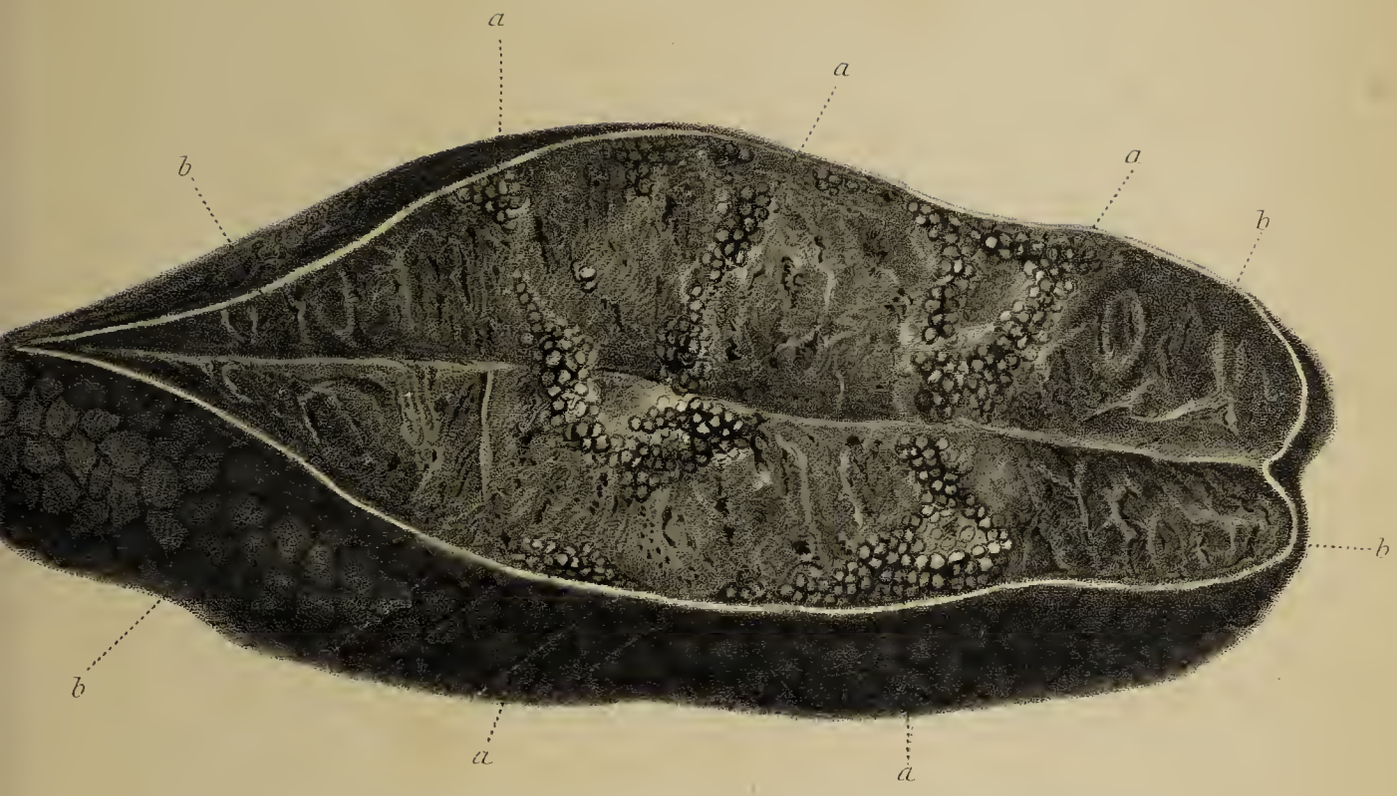
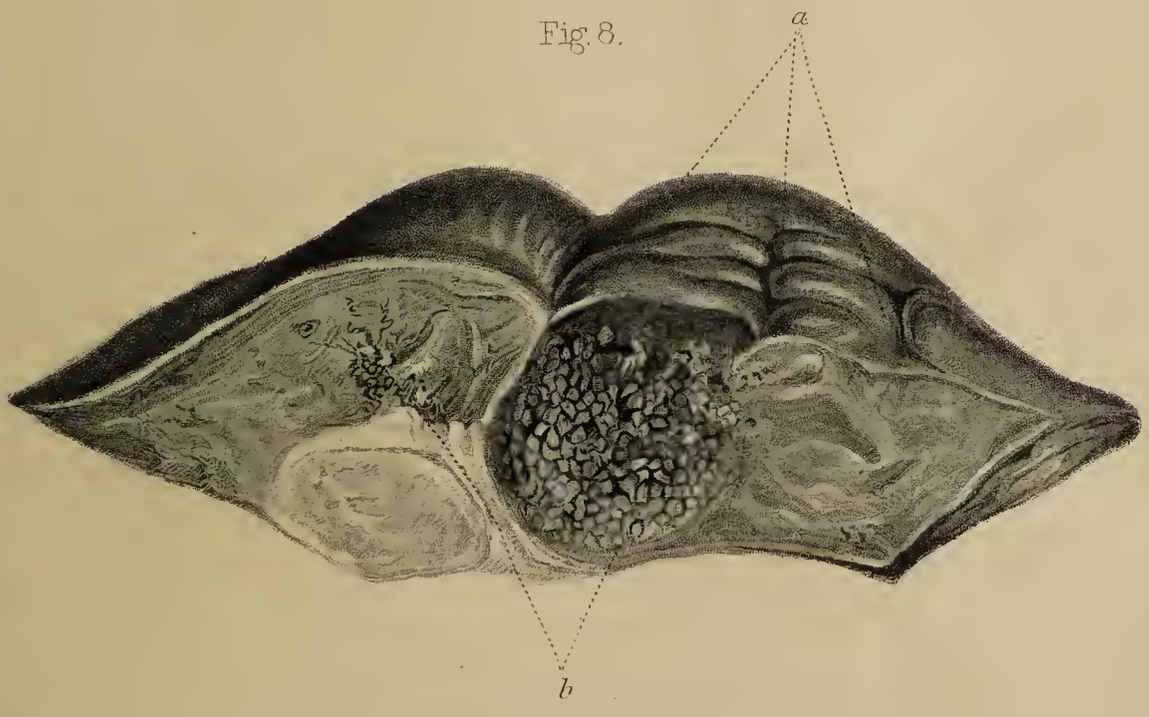


Fig. 8.



Drawn by W. Branson.

Engraved by H. Adlard.

Fig. 1

Section of Bronchial glands.

Fig. 2.

Senile lung.

Fig. 3.

Carbonaceous lung with chronic inflammation.

H. Adlard, lith.

OBSERVATIONS

ON THE EXISTENCE OF

FREE CARBON IN THE HUMAN BODY.

BY JAMES PAXTON, M.D., RUGBY.

READ AT

THE FIFTEENTH ANNIVERSARY MEETING

OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION,

HELD AT DERBY,

ON WEDNESDAY AND THURSDAY, AUGUST 4TH & 5TH, 1847.

FOR some time past I have been occupied in collecting and arranging pathological evidence relating to the modes of production, the forms of retention, and the remarkable extrication of uncombined carbon in various parts of the human body. There are not wanting instances of the deposition of free carbon very manifest during life, but it is more frequently observed in *post-mortem* inspections, and more especially invading the pulmonary tissue. The fruits of these investigations I have much pleasure in placing before this Meeting of the Association.

It is a curious fact, that the only elementary substance as yet detected in organized bodies, chemically uncombined, is carbon.* There is no part of the animal system in which it is so frequently met with as in the bronchial glands. The true cause of their blackness, I believe, was first demonstrated by Dr. Pearson.†

* The circumstance of mercury having been found in the bones ought not to be urged as an objection to the above statement, since its introduction into the system is not the result of functional, but from mere mechanical causes.

† *Philosophical Transactions*, 1813, p. 166.

Whenever there are pulmonary lesions of a lengthened duration, or any mechanical interruptions to the respiratory functions, these glands become the repositories of carbon; the effect of which is to produce a degree of enlargement and induration. Fig. 1 represents sections of bronchial glands, exhibiting the distribution of this substance. I have a specimen of carbonaceous bronchial gland enormously increased in its dimensions, and of an almost scirrhous density, with the pneumogastric nerve adherent to it. It is not unfrequently the case that the bronchial glands are so loaded with carbon that they are of an uniform inky colour. The extent of black discolouration bears some relation to the age of the person, to the state of the lung, and to the nature of the air breathed, particularly to the quantity of carbon it contained. The bronchial glands are always proportionably larger and blacker in those who are affected by chronic disease of the lungs.*

In persons advanced in life there is a disposition to carbonaceous retentions, more especially in the lungs; it indicates the period of senile atrophy at which they have arrived. A certain amount of black lines in the interlobular tissues, a grey or black web in the interior, occupying a greater or less space, with specks of various dimensions and granules of the same appearance, constantly characterize the lungs of the aged. A chemical analysis by Guillot† has proved this black matter to be exclusively carbon, in an exceedingly minute state of division. When this carbonaceous matter is blended together with the animal fluids it becomes a pigmentum nigrum, corresponding to the secretion of the choroid membrane, and to the ink of the cuttle-fish. The colouring matter of all these substances is animal charcoal, identical with the animal charcoal artificially produced in its indestructible properties, and remarkable in its resistance to the action of the strongest nitric and hydrochloric acids or the caustic alkalies.‡

Here I wish to be understood that the carbon of the lungs in the aged is not always derived from the inspiration of impure air, but

* Meckel.

† *Archives Générales de Médecine*, 1845.

‡ When a bronchial gland is boiled for some time in diluted hydrochloric acid, the animal matter is dissolved, and the pure carbon, by repeated washing, may be collected on filtering paper. I have further tested this substance by exposing it to a red heat in a closed vessel, but it remains unchanged.

Fig. 4.

Tuberculosis with carbonaceous deposit

Fig 5.

Hepatized lung with carbonaceous deposit.

Fig. 6.

Simple carbonization of lung.

H. Adlard, lith.

that it appears frequently, at least, to depend on insufficient combustion. Fig. 2 is a drawing taken from a portion of lung of an old man, who, for a number of years, was troubled with cough and dyspnœa. A vesicular rhonchus was heard, if not in the ordinary breathing, yet constantly in attempting a deep inspiration. The dark parts are somewhat consolidated, while the remaining lobules are emphysematous.

Chronic pneumonia, whether simple or accompanied by tuberculous accretions, as a consequent affection, occasions accumulations of carbon, which are unequally insinuated in the pulmonary textures. It may be collected in large black masses, as in Fig. 3, or it may be scattered in smaller isolated spots; at other times we find the black spots irregularly arranged in clusters. From such specimens we shall be able to form some tolerable conception of the results of chronic inflammation in the production of carbonaceous deposits. Hence vascular congestion has encroached on the air-vessels, and obliterated much of the areolæ, with even the ultimate ramifications of the bronchi. The air and blood are now no longer in contact, the extrication of carbonic acid ceases, and free carbon is detained in the lungs. We often observe large cavities at the apex lined by a carbonaceous pigment. During life these cavities communicated with the bronchi, therefore with the attendant cough was grey expectoration proceeding from a mixture of this substance with the mucous and suppurative secretions.

Tuberculosis or true phthisis pulmonalis, as it advances to a fatal issue, destroys the vesicular and tubular structures, consequently the aërial spaces become more and more limited, and, in proportion to the extension of the disease, the chemical changes required in respiration are equally limited. If the disease is protracted, similar depositions, from the causes just mentioned, take place; sometimes we perceive them centrally in the tubercle, but usually the carbonaceous depositions circumscribe the tubercle, as in Fig. 4.

The effect of such black infiltration is induration of the part, with shrinking and corrugations, as in the superior portion of Fig. 5. There are, however, cases of carbonaceous lungs, in which there is no obvious alteration in form, the carbon being simply diffused through a congestive organization, as may be seen in

Fig. 6. The poor fellow from whom this was taken had vegetations of the aortic valves, which rendered the heart inadequate to the duties of propelling the circulation through the lungs, and consequently the process of oxidation was suspended, then decomposition of the blood followed.

It is not my intention to review every known phenomenon relating to the retention of carbon, but merely to glance at the fact of its being found in various parts of the animal system. We feel little surprise at the discovery of carbon in the organ destined to decarbonize the blood; but we are rather astonished at its appearance in the organs remote from the lungs,* as, for instance, in the specimen before us, (Fig. 7,) in which we observe an elaboration of carbon in the mucous and submucous tissues of the colon. It is very irregularly distributed, for in some parts the colour is faint, while other parts are intensely dark, and the colouring matter is collected into little bodies, about the size of hemp seeds.

I wish specially to draw attention to the consequences of carbonaceous affections of the lungs, particularly as there is a vague notion referred to by Hasse, that black deposit (denominated pseudo-melanosis,) is not only innoxious, but actually opposes a barrier to the encroachments of tubercles, and is "the almost unfailing concomitant of reparation of pulmonary disease."† Another admirable pathologist has asserted "black pulmonary matter to be altogether compatible with perfect health."‡ Such views, however, are unsupported by the cases I have examined. On the contrary, I regard melanotic stains as marking a stage of degeneration, in which the vascular and aërial apparatus is most seriously involved. So far as uncombined carbon invades the lungs, in the same proportion are the circulation and the respiration impeded. We may, therefore, consider productions of black matter as no other than an unmixed evil. When added to tubercular mischief, it only increases the obstacles to the maintenance of the vital and chemical functions of the lungs, by further abridging the areolar surface,

* Carbon is found in tumours. There is a specimen in the collection at the Museum of the Hospital at Derby. No. 2,684 in the Pathological Room of the College of Surgeons, in London, may be referred to, as another example of this kind.

† Hasse's *Anatomical Description of Disease*. Sydenham edition, p. 381.

‡ Dr. Hope's *Morbid Anatomy*, p. 54.

and by obstructing the escape of certain normal and abnormal secretions which might happen to be the attendants on the carbonaceous diathesis.

To what causes are such retentions of carbon to be attributed? Brockman thought it "an effort of nature to relieve the circulation of a surcharge of carbon." Hensinger, I imagine, approaches nearer to the correct theory; namely, a deficient elimination of carbon, and particularly of carbonic acid, assigning this reason for the opinion,—"Carbon being principally found in organs which ought to be the natural outlet of this element."*

In the cases I have studied, the retention of carbon arose under the following circumstances:—1st. During the reduction of animal power by lengthened years, when the pulmonary organs seem unequal to the task of expelling carbonic acid. 2ndly. Where the existence of disease prevents both the reception of oxygen and the escape of carbon from the lungs. 3rdly. Where the individual lived in a situation in which we might suppose there was insufficient oxygen in the atmosphere he breathed. It is not unreasonable to assume that every one of these causes, or a combination of them, may be sufficient to account for the retention of carbon in its passage through the vessels.

The next class of cases to which I shall advert are those in which carbonic acid, under certain morbid conditions, is decomposed on the surface, the carbon uncombined remaining on the skin. The extrication of carbon by perspiration is easily demonstrated by the colour of the linen when worn too long a time. Free carbon also is deposited on the epidermis of old persons, particularly under the nails, and "where free access of oxygen is impeded; for example, in the axilla and in the soles of the feet."†

The most extraordinary instance of the production of carbon I have ever witnessed is that of a young lady, who having been in ill health for some years, from an affection of the heart, has now exudations of pure carbon on the skin round the orbits and about the mouth. It is washed off in the morning, but it reappears in the evening. When wiped away with a napkin, we are

* *Ueber anomale Kohlen-und Pigmentbildung. Eisenach.* 1823.

† Liebig's *Animal Chemistry*, p. 29. By Gregory. Edinburgh.

immediately struck by the black sooty appearance. In a word, this exudation has all the properties of the smoke collected from the flame of a lamp.

A similar case is recorded in the *Medico-Chirurgical Transactions*, of transpiration of carbon from the forehead.* There is, therefore, competent authority for asserting that vital chemistry is capable of reducing one of the component parts of the body to its original element.

The series of cases just mentioned are entirely to be ascribed to an internal origin; the remote cause is organic, but the immediate cause is chemical, and constitutes a train of features attendant on the diversified diseases which interfere with the economy of respiration. Thus, the condition of the intestine, Fig. 7, is the result of an impediment to the reception of oxygen in the lung. On the other hand, the lung, Fig. 6, has become black and engorged from impaired forces of the circulation, owing to diseased valves of the heart.

The last series of carbonaceous affections which I shall have occasion to notice are those in which the introduction of carbon into the lungs is from external and incidental causes. I allude to the inhalation and absorption of molecules of carbon suspended in the air in the form of smoke. In manufacturing towns, the ordinary carbonaceous lung is very common. The Professor of Medicine in Queen's College, Birmingham, has "never examined the body of an artizan, who was exposed by his occupation to the respiring of an atmosphere containing carbonaceous matter, without finding his lungs more or less blackened by it."† The effect of this during life is to interpose mechanical impediments to the functions of the lungs, in addition to the irritation excited by the presence of extraneous matter.

One species of this series of carbonaceous lung is peculiar to those who labour in coal mines. Fig. 8 is a sketch of true anthracosis, taken from a specimen in the collection of the Royal Medical Society of Edinburgh, showing the miserable condition of lung to which coal miners are liable. There may be seen some fine jet black lungs in the Museum of the College of Surgeons in

* *Medico-Chirurgical Transactions*, 1845.

† Dr. Wright, in *Medical Times*, November 29, 1845.

Fig. 7.

Carbon deposited in the submucous tissue of the Colon

Fig. 8.

Anthracosis.

H. Adlard, lith.

the same city. Just imagine the lungs carved out of a piece of coal, and you have a perfect idea of these specimens. I have in my possession a portion of miner's lung, beautifully spotted, given to me by Dr. Peacock. In describing the colour, it would be obvious to any one who would do me the favour to inspect it, that I have not exaggerated the description when I say that the whole of the pulmonary tissue is penetrated by minute atoms of carbon. Dr. Ayres did me the favour to examine it, and assures me that it contains a large portion of carbonaceous matter.

Perhaps there has been enough produced to prove that great damage is sustained by the pneumonic system, when, from whatever cause, carbonic acid is decomposed instead of being thrown off by expiration and the secretions. We ought to be no longer under the erroneous impression that the retention of uncombined carbon has any other than ill consequences. I have also endeavoured to exhibit the equally injurious effects of breathing an atmosphere impregnated with smoke or coal-dust. To follow up the inquiry and to multiply instances would not be difficult, but does not fall within the compass of the present communication. The latter division of my subject is still under the deliberation of the Government, and it is a subject on which all ranks would do well to reflect. If, in addition to much that has been lately published on these subjects, I have brought before you some direct evidence of the nature and consequences of carbonaceous affections, I have obtained my object. Philanthropists and philosophers have pointed out preventives if not remedies.

In the pathological division of the Museum of the College of Surgeons, in London, the preparations numbered 1,462, 1,477, 1,648, 1,798 A, may be referred to as fine specimens of several states of the lung here described.

CASE OF

MEDULLARY SARCOMA,

TOGETHER WITH SOME OBSERVATIONS UPON

THE FORMATION AND GROWTH OF THESE TUMOURS.

BY EDWIN MORRIS, M.D., & M.R.C.S.E., &c.,

Surgeon to the Spalding Dispensary.

Richard Wade, aged twenty-one years, a boatwright, of temperate habits, and very active, has always enjoyed good health. About four years since, when at work, he accidentally fell backwards upon an iron hook, which penetrated between the anus and the tuberosity of the ischium, on the right side. There was very little hæmorrhage, and he suffered but little inconvenience at the time, and after a few days the part was quite well. About twelvemonths afterwards he first began to feel an unpleasant sensation about the anus: he, however, thought that he had the piles, and took no further notice of it. For more than two years he suffered, more or less, from lancinating pains about the anus and perinæum, and took a variety of medicines, at the recommendation of his friends and neighbours. In December, 1845, he first experienced a difficulty in passing his motions, and states that they were like thin pieces of tape, as if they were pressed against something. He was necessitated to take drastic purgatives to procure an evacuation. In May, 1846, he was advised by his family to have medical assistance; he therefore consulted Mr. Vise, who, after an examination, felt some little hesitation in deciding whether it was a case of chronic abscess or a tumour, the case being of such a mixed character. He now began to have great pain in his right knee, which caused him to walk lame. The pain became very great, and the swelling more prominent, so much so that he was unable to walk or sit down, being obliged to kneel

in his chair when up, and rest his arms upon the back of it. Becoming much worse, and finding but little relief from the remedies employed, he took to his bed, and was obliged to take a teaspoonful of laudanum every night to procure ease and rest. He gradually became worse, and unable to move his right leg; he could not bear it to be moved in the least, so intense was the pain; indeed, the weight of the bed-clothes was at times too much for him to bear. He was quite unable to be moved off his bed, and passed his motions with great difficulty as he was lying.

I first saw him June 27th, 1846. He was much emaciated, and looked care-worn and dejected; he had gradually increased the quantity of laudanum to a teaspoonful three or four times a day. Upon examination I found a firm swelling projecting up the integuments over the situation of the great sacro-sciatic notch, through which, indeed, it appeared to be protruding. The coccyx is pushed forcibly backwards and to the left side, and appears as if it would come through, so tense is the skin covering it. The right leg is œdematous and quite immoveable. Upon passing the finger into the anus, a hard unyielding tumour can be felt pressing the right side of the rectum inwards, and it appears to occupy the whole of the great sacro-sciatic notch. I felt satisfied that the tumour was of no ordinary character, and that it would set at defiance all surgical art; a palliative plan of treatment was therefore recommended. I did not see the case again until October 25th, exactly four months from the time I had before seen it. I now found that the disease had rapidly progressed to its present immense size, occupying the whole of the posterior part of the dorsum ilii, extending forwards over the anterior portion of the crista ilii, bulging over upon the abdomen; it also fills up the space on the anterior part of the dorsum ilii between its anterior-superior spinous process, and the acetabulum. The whole external surface of the tumour is very tense and varicose; it is very irregular in its shape, and projects more in some directions than others. There are several little prominences upon the tumour, which are quite soft, as if they contained a fluid: these are well shown in a drawing which I have had made. The tumour now presses firmly upon the perinæum, so much so as to elongate the anus and very much displace and somewhat invert it; indeed, there is some little difficulty in making out its precise situation. He has not passed

any urine the last three days. The abdomen is very hard and swollen; does not suffer more than usual. Having determined to attempt to pass a catheter, the difficulty was to get him in as favourable a position as we could for that purpose: he could not turn upon his back nor sit upon the edge of the bed; we were obliged, therefore, to have him lifted completely out, and held up between two persons. There was no difficulty in passing a catheter down as far as the membranous portion of the urethra, but beyond this we could not, by any possible means, pass a catheter of any size or shape; there appears to be some solid resistance; no doubt the tumour now presses so firmly against the urethra as to obliterate it: we therefore had him placed in bed again, and gave him, in addition to his usual quantity of laudanum, a dose of morphine.

Monday, October 26th.—He has passed a comfortable night; has not yet passed either urine or motion. Pulse strong; tongue rather furred. He is troubled very much with hiccup; indeed, he had it slightly yesterday; to-day it is worse. He has taken a sufficient quantity of nourishment.

October 27th.—Has passed a tolerably good night; has not yet passed either urine or motion. An attempt was made to give an enema; it was impossible to do it, inasmuch as the tumour presses so firmly on the rectum as to make it impervious. The hiccup comes on in paroxysms, and is very violent while it lasts. Pulse, 120; tongue rather dry; the abdomen is much more distended. He has very little pain, and has no inclination to pass water. He has taken a little brandy and sago during the day, and the usual quantity of laudanum.

October 28th.—Has passed a restless night, and has been violently sick three times, and thrown up a quantity of bile; has not yet passed urine or motion. The hiccup is very troublesome. Pulse, 110; body much more swollen. The propriety of submitting to the operation of having the bladder punctured above the pubes was suggested, but neither he nor his friends will admit of its being done.

October 29th.—Has had very little sleep during the night; has suffered much from pain in the body. Pulse, 120; no urine nor motion has yet been passed; it is a week this day since he had relief either way. Hiccup still troublesome, but he has not been

sick since yesterday. The only nourishment he has taken is a little sago; takes his laudanum as usual.

October 30*th.*—Has passed another restless night; has been twice sick; hiccup still continues. Pulse, 116; tongue moist. Has taken only one cup of arrow-root and a little coffee. About a teaspoonful of mucus has oozed out of the anus; body is very tense and painful when the hiccup comes on.

October 31*st.*—Has slept for some time during the night; has taken very little nourishment; has been violently sick. The right arm is slightly paralysed. There has been a mucous discharge from the anus, sufficiently so as to saturate nearly a small napkin; there has also been passed a motion, about the size of a nut. Pulse, 76; he is evidently sinking. He now became gradually insensible, and died at seven p.m.

November 1*st.*—*Sectio Cadaveris, sixteen hours after death.*—Mr. Vise first commenced by making a crucial incision over the substance of the tumour; the angular flaps thus formed were dissected back, and the whole mass exposed; the little prominence observed upon its surface, contained medullary matter. The tumour was firmly bound down by the fascia, which was considerably thickened. Upon dividing this freely, the tumour presented a lobulated appearance, and when pulling it backwards from off the dorsum ilii towards the sciatic notch, I accidentally burst one of the lobules, when a quantity of a jelly-like substance escaped, which had a remarkably glutinous feel: the cyst in which it was contained was firmly attached to the inferior border of the crista ilii, and to the fascia covering the glutæi muscles. The mass was now lifted up and forced backwards towards the sciatic notch, when it emerged from the pelvis. We now found that by its pressure from within it had caused absorption of a great portion of the ilium, including the posterior inferior spinous process, as far up as the ridge from which the glutæus medius arises. Several small spiculæ of bone were adherent to the tumour when raised up: that portion of the right side of the sacrum which gives attachment to the pyriformis muscle, was also absorbed. After some little difficulty the tumour was pulled out of the pelvis, which it completely filled; it was not adherent to any portion of it: the rectum was empty, and forced backwards with the coccyx; the prostate and bladder were carried upwards

towards the symphysis pubis; the prostate gland was quite healthy. The morbid mass had more or less displaced the various organs within the pelvis, but none of them had partaken of the diseased action: the pressure from the tumour upon the prostatic portion of the urethra was quite sufficient to account for the retention of urine. After the tumour was removed from the pelvis, the distended bladder was distinctly visible projecting in at its superior aperture. The body was now turned upon its back, and the integuments of the abdomen were reflected downwards upon the thighs, and the contents of the abdomen fully exposed. The bladder was much distended, and reached upwards to the transverse arch of the colon; the enlarged size of the bladder caused its lateral ligaments to be very distinct; by pressing upon it the urine was forced out per *vias naturales*, now that the interior of the pelvis had been relieved of the tumour. The abdominal viscera were healthy; the descending portion of the colon and its sigmoid flexure contained a quantity of scybalæ; the fæces, indeed, were unable to pass beyond the brim of the pelvis, on account of the pressure of the tumour.

Having given a promise to the friends of the youth that no portion of the body should be removed, I availed myself of the services of a young artist of this town, who, although unaccustomed to pathological sketching, has nevertheless given a very correct description of a section of a portion of the tumour, which represents well the true character of it. The lobulated appearance is recognizable, together with the condensed cellular tissue which separates them. The bloody points are well shown where effusion has taken place amongst the medullary matter from congestion and rupture of the vessels.

Laennec describes three varieties of medullary sarcoma—the *encysted*, *unencysted*, and *infiltrated* or *diffused*. The case in question is of a mixed character, however, and partakes more or less of all three varieties.

It is truly surprising with what rapidity the tumour grew: it emerged from the pelvis in June, and by October had attained its immense size. The youth's sufferings were occasionally of a most acute character, and he sought relief from his terrible malady by having recourse to stupefying doses of laudanum.

I first had an opportunity of seeing the case through the

kindness and courtesy of Mr. Vise, surgeon, of this town, under whose care the youth was. I am also greatly indebted to that gentleman for the assistance he afforded me in granting every facility, so as to enable me to give the case in detail.

In the treatment of the above case little could be done except in relieving the boy's sufferings by opiates, for the tumour was so situated as to baffle all surgical interference, on account of the important organs which were in its immediate neighbourhood; otherwise extirpation of the morbid growth would have been desirable, and might, no doubt, have been performed with success, inasmuch as no organs of importance were involved in the disease. It surrounded and compressed several important parts, but did not communicate a diseased action to any of them.

Medullary sarcoma is generally considered by pathologists to be a constitutional disease, of a specific and malignant character, rapidly involving all adjacent parts and structures. The above case is, however, an exception to this statement, and in forming our prognosis we should not lose sight of this important fact. Mr. S. Cooper, in his *First Lines*, mentions several cases of complete recovery after extirpation, and the disease did not manifest any disposition to return. Liston, in his *Elements of Surgery*, also states,—"In several instances I have removed encephaloid tumours from the situation of both the mamma and testicle, and the disease did not return." The profession is under great obligations to the late Mr. Abernethy, for his ingenious nomenclature as regards the classification of tumours, for with him originated the idea of naming all tumours in accordance with their anatomical formation. This at the time was considered an important step towards rescuing from confusion this department of the pathology of surgery; but although the arrangement at first appeared very plausible, it was subsequently discovered to be defective. The term "medullary sarcoma" was first applied by Mr. Abernethy, on account of the structure of the tumour resembling the medullary substance of the brain, and the name is very appropriate, inasmuch as it gives correctly its anatomical structure, for the disease resembles very much, both in its chemical and physical properties, the brain itself.

As regards the production of medullary sarcoma, surgeons know but little, and pathology has failed to enlighten us hitherto on the subject. There are, however, three circumstances essentially

necessary for their formation and growth, viz.:—First, a predisposition in the individual; secondly, an exciting cause; and, thirdly, inflammatory action. For instance, a person with this peculiarity of constitution receives an injury, such as happened in the case above detailed: effusion of blood takes place; it then coagulates; chronic inflammation is established, and, instead of the effused blood being removed by absorption, it forms the nucleus of a new and adventitious growth, differing entirely in every respect from the adjacent tissues of the body. When once formed it rapidly increases in size, and, if of a malignant character, involves all structures in the morbid action, and is subsequently productive of the most disastrous consequences. The peculiarity of constitution which I have alluded to, as being necessary for the formation of medullary sarcoma, is, I apprehend, of a similar character to that which is present in individuals who have tubercles in the lungs, and which induces these deposits at certain critical periods to take on a diseased action, and to run through the various stages constituting pulmonary phthisis; indeed, dissections of persons who have died from the effects of medullary sarcoma, have shown the disease also to have existed in the various internal organs of the body. The cause of this singularity of constitution will, I think, ever remain wrapped up in mystery.

At first, the disease is seldom attended with a great deal of pain: the tumour is very tense, and conveys the feeling when touched as if it contained a fluid. It is not in general very rapid in its growth at the commencement, but as the disease progresses, its enlargement goes on with much greater rapidity; the integuments covering it then become remarkably tense and shining, and large venous branches ramify in all directions. An early symptom indicative of this disease is a pale, dejected, careworn look, which should always put us upon our guard as regards the malignancy of the disease. Whenever a tumour presents the above local symptoms, together with the peculiarity of countenance described, the experienced surgeon will have no difficulty in forming a correct diagnosis. It is of the greatest importance that we should be enabled to distinguish tumours of a specific from those of a simple nature, to prevent a useless waste of valuable time in endeavouring to promote the removal of them by remedial and local applications, which ought rather to be engaged in

extirpating the morbid mass. As the disease advances ulceration of the skin covering the tumour takes place; a medullary substance is soon projected out, which bleeds at times profusely, hence the name *fungus hæmatodes* by Mr. Hey. This appellation, however, is only admissible at this particular period of the disease, the term "medullary sarcoma" being far preferable, inasmuch as it denotes correctly the peculiar structure of the tumour. When medullary sarcoma is once formed in parts of the body deeply seated, it makes its way towards the surface in that direction where it meets with the least resistance; but should it be pent up, it will, by its continued pressure and increasing size, cause absorption of the bone, impeding its gradual progress, and makes its way outwards to the external surface of the body, as in the case I have already given. Cases are recorded where it has formed in the antrum, when it has forced its way through the orbit to the brain; indeed, the frightful objects which occasionally present themselves suffering from this dreadful malady, show but too plainly the destructive and fatal mischief it is capable of perpetrating.

After this description of the character of medullary sarcoma, it is almost unnecessary for me to state how important it is that we should pay especial attention to tumours in their early growth, and form a correct diagnosis as soon as possible, so that we may be able to adopt energetic measures for their immediate eradication. With respect to the treatment of medullary sarcoma, the Materia Medica has been run through in vain for a medicine capable of relieving and correcting that state of the constitution which predisposes to the formation of the disease. Our only available means, therefore, of eradicating it, is by an early removal of the tumour by the knife, whenever it is so situated as to admit of this being done with safety to the surrounding parts, and before any of the glands and adjacent tissues of the body have partaken of the diseased action.

FEVER,

IN ITS RELATIONS TO SANITARY REFORM,

BEING THE

ADDRESS IN MEDICINE,

BY W. DAVIES, M.D., EDIN.,

PHYSICIAN TO THE BATH UNITED HOSPITAL.

DELIVERED AT

THE SIXTEENTH ANNIVERSARY MEETING

OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION,

HELD AT BATH,

On Wednesday and Thursday, August 16th & 17th, 1848.

Mr. President and Gentlemen,—I can assure you it is with feelings of no ordinary diffidence that I stand before you on the present occasion, to deliver the Annual Address in Medicine; I can only crave at your hands, that which I am sure you will grant me, great indulgence, and a lenient criticism for the numerous faults which are sure to encumber my production.

The invitation which I received from the Secretary of our Association to deliver this Address, was accompanied by a request on the part of the Council, that it should not include, as heretofore, a retrospect of the progress of medical science, as a whole, during the past year, such retrospect being no longer desirable, in consequence of the elaborate *Half-yearly Abstracts and Retrospects,* edited by Dr. Ranking and Mr. Braithwaite, but should be confined to some one or more subjects, at the choice of the writer. It is obvious that the change thus introduced into the character of the Address, has altered altogether, and much increased the responsibility of the writer; for it would only have been necessary to refer to the past volumes of the *Transactions* of the Association, to select from the many able

addresses which those volumes contain, a model whereby to fashion my own; and a form being fixed on, the value of the Address would depend on the extent of the selections from the medical literature of the past year, and the judgment with which they were displayed. All such guidance I have been deprived of, as the only Address that has been delivered on the present plan—that by Dr. Shearman, of Rotherham—remains as yet unpublished. Under these circumstances, I felt it to be no light matter to select a subject on which to address a meeting, composed, as this is, of a large proportion of the best informed members of the medical profession resident in the provinces.

It has been the practice of my predecessors in this office, to lay before the meeting some memorials of such leading members of our profession as death may have removed during the preceding year; the list on the present occasion is a long and a dreary one, and has been already appropriately introduced by our President.

It has also been usual of late years, while the subject of medical reform has been occupying much attention, both within and without the profession, to pass under review such topics as have more particularly occupied the medical mind during the past year. This task I shall altogether omit:—First, because the subject of Medical Reform is far too extensive and complicated to be advantageously discussed within the very narrow limits that I could devote to it; and secondly, because I have seen little reason to congratulate the profession on the spirit in which the various objects, by some thought desirable, have been sought to be attained. I have never been able to comprehend clearly any one specific object which the profession, as a whole, desires. I have seen a great deal of acrimony and ill-feeling set afloat, to poison the springs of that brotherly good-will which should unite in one body every honest member of a liberal profession. It has appeared to me that medical reform has been considered far too much in its individual, and too little in its universal aspect; that the small and passing interests of individuals and of corporate bodies have been allowed to occupy that attention which should have been devoted to a consideration of what is just and what is true in the nature of things. Men are too apt to imagine, if the bright anticipations which they have formed fail to be realised, that the defect lies without, and not within; and that under some different system, their career would

have been more fortunate: whereas I would humbly, but confidently submit, that the reform, above all others, calculated to promote the interests of our profession, is such as no legislature can effect—a reform of mind and will—of the one, a more diligent training in the science of our profession; of the other, a stricter discipline in that charity which thinketh no ill. And I believe, further, that just in proportion as the minds of men are occupied in the exciting discussions of legal reform, so are they rendered unfit for the advance of that self-reform of which I have spoken above. On these grounds, I must consider the formation of the Manchester Ethical Society as a step in the right direction, though perhaps its rules are susceptible of considerable improvement. I will conclude these few prefatory remarks with a quotation from a celebrated German physician and philosopher: "Whatever thou doest, do it with integrity; if thou studiest, let it guide thy studies; and then, as to whether thou shalt prosper in what thou doest, leave that to God. Thou hast most surely left it to him when thou goest to work with true and honest purpose; with the attainment of that integrity thou wilt also attain unbroken peace, inward cheerfulness, and an unstained conscience; and in so far thou wilt assuredly prosper." I now pass to the special object of my Address.

The sanitary condition of the great towns of the empire has of late years occupied much of the attention, not only of the medical profession, but also of the public. Various commissions of inquiry concerning the health of the inhabitants of such towns have been formed, and various reports thereof published; the result has been a far more accurate knowledge of the kinds of diseases most prevalent, and the amount of fatality attendant on each, than was previously possessed. Of all the diseases whose ravages have thus been brought to light, none has attracted so much attention as fever. The reasons of this are obvious. During all periods of medical history, the subject of fever has furnished a fertile source of medical discussion; and down to the present time, opinions regarding the nature and cause of fever remain different and opposed. The great attention which has been devoted to this subject during the last few years, while it has been the means of extending to all classes certain general notions on the subject, has, I believe, very greatly complicated the matter in relation to scientific medicine, by

the introduction of a class of writers and speakers who have drawn their conclusions from the small sphere of their own immediate observation, without having studied the literature of the subject, and compared their own crude and hasty generalizations with the broader inductions of others. This defect, in my opinion, pervades more or less extensively all the reports that have been published on the cause of fever, and the means of prevention, by different commissions of inquiry, from 1839 to the present day. Hence, then, from the great practical importance of the subject, from its great interest in relation to scientific medicine, and from the numerous discordant notions by which it is surrounded, I have thought certain points in the history of fever not unworthy to occupy the attention of so important a meeting of medical men as I have now the honour of addressing.

I purpose to direct your attention especially to the relation which exists between the cause of fever and sanitary reform. But as I apprehend much of the confusion which exists on this subject to be occasioned by the confounding together, under one name, diseases essentialy distinct,—an illustration in medicine of an observation of Dr. Reid, while treating of the science of mind,—"That the *ambiguity of words*, and the vague and improper application of them, have thrown more darkness upon this subject than the subtlety and intricacy of things;" and, of the remark by Locke,—that "The greatest part of the controversies that perplex mankind, depend on the doubtful and uncertain use of words;"—it will be necessary, before entering on this subject, to define, as accurately as I can, the distinctive characters of the diseases in question; and, in the first place, I will endeavour to establish that there is a form of fever to which the following description accurately applies:—

1st. That its progress is marked by a specific eruption.

2nd. That it is propagated by contagion.

3rd. That there is no distinct evidence of its ever spreading in any other way than by contagion.

4th. That the same individual is not, for the most part, liable to more than one attack during life.

In proportion to the degree of clearness with which these four points can be established will be the claim of the disease to be

admitted into the class of exanthemata. In this paper it will be designated typhus, or maculated fever.

1st. Typhus is characterized by a specific eruption. In the evidence to be adduced on this point I will omit the statements of the older authors, as not sufficiently definite for my purpose, although many of them in their description of the disease, no doubt refer to the same thing,—viz., Huxham, Hildenbrand, Drs. Barker and Cheyne, and others. Professor Alison, writing on the Edinburgh fever of 1827, says,—"It should not be overlooked in any discussion regarding the contagious nature of fever, that in those seasons when it prevails most epidemically, and very remarkably in the present, it is very frequently attended by an eruption of the skin, closely resembling what is seen in some of the contagious exanthemata, more particularly measles. A majority of the cases treated by me in the hospitals during the present year, had more or less of this eruption." And, again, "Such cases of spotted fever may be said to form the link that connects the order of fevers with that of contagious exanthemata."*

Dr. Peebles quotes Dr. Palloni on the epidemic of 1817, as follows:—"I have ascertained," says Dr. Palloni, "after the most attentive inquiry, that the nature and form of the eruption are always the same, not only in the actual epidemic, but in all the cases of exanthematous fever produced by contagion, and are opposed to the spurious symptomatic appearance which sometimes accompanies fevers of a putrid or malignant character."† Further on Dr. Peebles writes,—"When I saw the patient before the seventh or eighth day, the exanthema was more or less clearly marked; and even in some of the cases that I did not see till the ninth or tenth day, it was still visible, either alone or mixed with petechial stains. I very rarely failed in discovering it in those patients I saw in their own houses, for there I had a better chance of seeing them early in the disease."‡

Dr. West, in a paper on "Typhus Exanthematicus," says,—"Forty-two cases presented the peculiar measle-like eruption, described by so many authors, which, in all those cases in which I have been able accurately to note the date of its appearance, first showed itself from the sixth to the eighth day, generally on the

* *Edinburgh Medical and Surgical Journal*, vol. xxviii.
† *Ibid*, vol. xliv. ‡ *Ibid.*

former."* He further remarks,—"That of the eighteen cases in which no eruption was observed, only five were admitted before the eighth day, so that some of those patients may have had the eruption, although it had disappeared before their admission."

Dr. Henderson, in his conjoint report with Dr. Reid, on the Edinburgh epidemic of 1836–7–8, says, regarding the eruption, "136 cases, of both sexes, were specially inspected with reference to this eruption. In 108 cases the eruption was found; in twenty-two it was not found: six of the twenty-two cases were not admitted till between twelve days and three weeks from the beginning of the fever; therefore, as will appear from what follows, it cannot be concluded that they had not had the eruption at an early period. Of the sixteen cases in which no eruption existed at any time, the greater number were slight cases; one only could be termed a rather severe case, extending to the fifteenth day: this case was not traced to contagion."†

Dr. Davidson, in the *Thackeray Prize Essay*, says,—"There is one fact, however, which powerfully supports the opinion that contagious typhus, in the great majority of cases, particularly in adults, is attended with the eruption, namely, that almost all the instances of fever which have occurred during the last six or seven years among the physicians, clerks, nurses, &c., of the Glasgow Fever Hospital, have been accompanied with this exanthema. We have made careful inquiries respecting this point, and have only heard of one or two exceptions, amongst, at least, 100 cases."‡

Dr. Copland, while treating of the confusion which some writers have made between the eruption we are speaking of and petechial stains, says,—"But the *exanthematous eruption* attending true typhus, is as characteristic of it as the eruptions of measles or of scarlatina."§

Dr. Watson says,—"The rash now described, stamps continued fever with one of the most striking characters of the exanthematous group of febrile diseases; but it certainly is less constant than the cutaneous phenomena of small-pox, measles, or scarlet-fever. It occurs much more regularly in some epidemics than in others. Fever is very rife in St. Giles's, and in other crowded parts of this

* *Edinburgh Medical and Surgical Journal*, vol. l.

† *Ibid.*, vol. lii.

‡ *British and Foreign Medical Review*, vol. xi.

§ *Dictionary*. Article, "Typhus."

town, just now, (1838,) our wards at the Middlesex are full of it, and scarcely a case presents itself without these spots. We speak of it particularly as the *spotted* fever; or, from the resemblance which the rash bears to that of measles, hereafter to be described, as the *rubeoloid* fever."*

In an elaborate essay on the epidemic fever of 1847, in the second number of the *British and Foreign Medico-Chirurgical Review*, is the following:—"It remains for us to particularize a little further with regard to the cutaneous eruption, and to show that, in all its characteristics, it maintains as determinate a relation to its proper fever as the cutaneous affection in corresponding maladies. First, it appears *definito tempore;* secondly, it manifests itself electively on some parts of the surface rather than on others; and, lastly, the spots have certain fixed physical characters."†

A few interesting cases have lately come under my own observation with reference to this question. I will give a sketch of six of them. The first case was that of an Irish woman, of the name of Rooke, who was admitted into the Bath United Hospital, under my care, during the second week of fever, the eruption at that time being very abundant, chiefly over the chest. The nervous system was in a very depressed condition, but under a pretty liberal use of stimulants she recovered, and was discharged on the 19th of February, 1848. A woman, named Carpenter, who had been six weeks in the hospital on account of chronic disease, and who, previous to her admission, had resided in a healthy rural district, took ill of fever on the 10th of February; on the sixth day from her attack, the eruption appeared on the upper part of her chest, and in a day or two became very abundant. The nervous system became profoundly involved, and she died comatose, on the eleventh day of the disease, the 20th of February, one day after Rooke had been discharged. At the time of Rooke's admission there was no other case of fever in the ward into which she was taken, and Carpenter's illness commenced about a week after the convalescence of Rooke had enabled her to sit by the fire and mingle with the other patients, whose maladies were such as to admit of their being out of bed, of which number Carpenter was one. No other patient in the ward took the fever.

* "Lectures." 1st edition.

† *British and Foreign Medico-Chirurgical Review*, No. 2.

The next case I have to mention came under the care of my colleague, Dr. Daniell. A man, named John Dunn, was admitted on the 4th of March, 1848; he was unable to give any accurate account of himself, but as far as could be judged, was then about the end of the first week of fever. The maculæ were very abundant, and the nervous system much affected; he died by a sort of compound lesion of the vascular and nervous systems on the 15th of March, eleven days after admission. Robert Stone had been in the hospital since the 2nd of February, more than a month previous to the admission of Dunn, and was taken ill of fever on the 13th of March, two days before the death of Dunn. The eruption in this case was very abundant, and the disease ran a very severe course; he recovered, however, and was discharged on the 28th of April. The beds in which the two men lay were near each other, and there was no other case of fever in the ward at that time.

The next case I will mention is that of a woman, Harriet Gates, who was admitted under the care of Dr. Daniell, on the 1st of April, suffering under maculated fever. In consequence of the delirium under which she laboured, being of a more active character than usual, the nurse of the ward was brought into more frequent and immediate contact with her than is commonly necessary. Gates ultimately recovered, and was discharged on the 4th of May. The nurse, who had been much fatigued by her attendance on this woman, was seized with fever on the 21st of April, twenty-one days after her admission. On the fifth day after her seizure, maculæ made their appearance, and became very abundant; and in her case, about the twelfth or fourteenth day, some of the spots seemed to pass into true petechiæ. She made a slow, but ultimately perfect recovery.

In attempting to estimate the import of these cases, it is necessary to understand that true typhus is a very rare disease in this city, as, until the commencement of the present year, no case of the disease had come under my observation, although I have performed the duties of physician to the hospital during more than two years; hence, when typhus does appear, more favourable opportunities than usual are presented for tracing the progress of the malady from individual to individual. Keeping this fact in view, it will be observed that I have described six cases of eruptive, or maculated fever; three of which, for the sake of distinction, I will term

original, the other three derived. It so happened that each of the original cases was admitted into a different ward, and that there was no other case of fever of any kind in either of those wards at the time of such patient's admission. Now if we consider—firstly, that maculated fever is a very rare disease in Bath—secondly, that at the time of the admission of each of the original cases described, there was no other case of fever of any kind in the same ward—thirdly, that each of the three derived cases had been in the hospital for a considerable time previous to the admission of the original ones; one upwards of a month, another six weeks, and the third a nurse of the hospital of several years' standing—and lastly, that a considerable amount of intercourse is shown to have existed between the two classes of cases:—if these facts are regarded, without the introduction of any mental idol, I do not see how any other conclusion is to be arrived at than that the two classes suffered under the same disease, and that the one was derived from the other.

In order to justify any other conclusion, it would be necessary to assume that a local cause of fever sprung up in three distinct wards of the hospital, at three different periods of time; and that the coming into operation of this cause, in each instance, agreed, both as to time and place, with the admission of patients labouring under the same disease. I am anxious to have this matter clearly apprehended, for two reasons—firstly, because it furnishes an argument in favour of the speciality of maculated fever, like producing like; and secondly, because it supplies a link in that, to my mind, perfect chain of facts and arguments by which the contagious property of typhus is proved.

It will, perhaps, be considered that I have occupied too much space in the attempt to establish the eruptive character of typhus, as the fact is to be found stated with sufficient clearness by several authors. In deprecation of this judgment, I would observe that a fact usually becomes established as a scientific verity, long before its operation on men's minds as a practical belief displays itself; and that the fact we are discussing is in the former, and not in the latter predicament, I have much reason to believe.

2nd. I now come to the second proposition, namely—That maculated fever is propagated by contagion. By the term contagion, I mean to express the means by which a specific malady is communicated from a diseased to a healthy person, without inquiring

whether obvious contact takes place, or whether the *materies morbi* passes by means of the atmosphere through an appreciable space; it is clear that nothing can act where it is not, and therefore in either mode of communication, I apprehend the system to become affected in precisely the same manner—namely, by the entering in and multiplying of the morbid matter in the blood, up to that point of saturation when its presence becomes incompatible with the normal performance of the functions of the body, and disease is the result. I have thought it proper to premise this explanation of the meaning which I attach to the term contagion, because certain writers have attempted to draw a distinction between contagion and infection; which distinction I believe to be not only useless, but contrary to nature.

If we admit in this discussion the dictum of Dr. Elliotson,—"That for *infection* to be *proved*, the individual who communicates the disease must go from the place where he resides to the spot where the healthy person is, and there give it to the latter,"—it will be observed that the cases I have described under the last head fulfil the conditions imposed, so that even according to the requirements laid down by Dr. Elliotson, the evidence in those cases is complete. Still I believe that perfectly satisfactory evidence of the contagious nature of typhus may be drawn from other sources; for example:—A large building, which has been from time to time used for various purposes and by different classes of persons, and never known, under any circumstances, to become the seat of fever, is at length appropriated to the purposes of a fever-hospital; fever-cases are admitted into it, and the necessary staff of physicians, clerks, nurses, &c., appointed; in no long time the whole medical staff and assistants suffer under a fever. Is not the evidence here complete that the fever under which the physicians and clerks suffered was communicated to them from the patients in the house? These are precisely the circumstances which have occurred more than once at Queensberry House, Edinburgh, and have been fully described and argued on by Dr. Alison.* To this paper I would refer for further evidence on this subject, and also to the writings of Drs. Christison,† Tweedie,‡ and Graves,§ with

* *Edinburgh Medical and Surgical Journal*, vol. xxviii.

† *Library of Medicine*. Article, "Fever."

‡ Work on "Fever.

§ "Clinical Medicine."

many others; as it does not seem necessary to occupy your time with long quotations, in proof of what every man of sound mind must admit, provided he has given the subject any attention.

The third proposition is,—That there is no distinct evidence that typhus ever spreads in any other way than by contagion. I am not in a position to discuss this proposition with advantage at present, so that I will return to it at the conclusion of this Address, by which time we shall have had under our notice other matters which bear on the question.

The fourth proposition is,—That the same individual is not, for the most part, subject to more than one attack during life.

There are few facts in the history of disease more calculated to arrest the attention of the physician than this,—that there are certain diseases which do not possess the power of affecting the same individual, as a rule, more than once during life; and the more perfectly developed the disease has been in the first instance, the smaller is the chance of any subsequent attack. All known diseases which possess this peculiarity are contagious, but the converse of the proposition does not hold, as some contagious diseases do not possess this peculiarity. But, again, I believe it will be found that all contagious diseases which run a more or less definite course of febrile action, do possess the peculiarity in question, namely, that of occurring only once during life.

It appears to me to be well-nigh demonstrable that the poisons of these diseases, namely, small-pox, measles, scarlet-fever, and typhus, are taken into the blood of the individual to be affected before the disease manifests itself, and that in the blood these poisons find the necessary materials for their own increase; hence they are contagious. It is probable that the particular material of the blood, by means of which these poisons are formed, becomes destroyed during the process, and not being essential to life is not reproduced, or only rarely, and after a long interval of time; and hence these diseases occur only once during life, just as no yeast would be formed by introducing that matter into any solution which did not contain gluten.

Now if these things be so, it follows that the period between the exposure to contagion and the commencement of the disease is that

during which the poison is accumulating in the blood; that the beginning of the fever corresponds with that amount of saturation which is no longer compatible with the healthy functions of the body; that the continuance of the fever indicates the period necessary for the maturation and infusion of the poison; and convalescence the complete attainment of that end. Hence, by substituting the word fever for disease, the following quotation from Sydenham, enunciates, I believe, an important fact:—"A disease, in my opinion, how prejudicial soever its causes may be to the body, is no more than a vigorous effort of nature to throw off the morbific matter, and thus recover the patient."

Sir Henry Marsh, in a paper "On the Origin of Fever,"* brings forward a number of examples where individuals were seized with typhus, immediately on being exposed to the concentrated effluvia arising, either from the bodies of fever-patients, or from their excretions; and on these facts founds an argument that the poison of typhus does not enter the blood before it produces its effects, but that these effects follow in consequence of an impression on the nervous system. Now, in the first place, it may be replied that nearly all the cases adduced by Sir Henry Marsh in support of his opinion, were persons (hospital-physicians and nurses,) subject to continued exposure to contagion, and therefore that the particular exposure which immediately preceded the attack, was only the last pound which broke the horse's back—the last drop of water which caused the vessel, already full, to overflow; and, besides, no one doubts that a violent mental emotion, of a depressing kind, which is stated to have taken place in those cases, would act powerfully towards giving effect to the action of the poison. Again, there is one argument which has always seemed to me fatal to the notion, that the occurrence of fever could be attributed to an impression caused by the poison on the nervous system; it is this,—that even supposing the one attack to be thus explained, how are we to account for the formation of a fresh supply of the same poison in the body of the individual in whom the disease thus sprang up? It cannot be supposed that so vague a thing as an impression on the nerves can give rise to the formation in the system of a definite and specific poison; different persons will be differently affected by the same cause acting on

* *Dublin Hospital Reports*, vol. iv.

the nervous system. Shakspeare knew this when he made the Jew say—

> "Some men there are love not a gaping pig;
> Some that are mad if they behold a cat;
> And others, when the bag-pipe sings i' the nose,
> Cannot contain their urine."

Thus much for contagious diseases which occur only once during life. There are other contagious diseases which may occur any number of times during the life of the same individual, such as syphilis, gonorrhœa, and scabies. The last of these is well known to depend on the presence of an insect. As regards gonorrhœa, there is no reason to suppose it any other than a purely local affection; and though syphilis no doubt affects the blood, still it is not necessarily attended with any febrile disturbance of the system.

There are two contagious diseases derived from the lower animals, hydrophobia and glanders, which, as far as we know, are always fatal, so that there are no means of judging whether they have a tendency to occur more than once during life or not.

There are febrile diseases not contagious, and from the attacks of which no immunity, as far as we know, is derived from having previously suffered under them; such are marsh or intermittent fevers, and, probably, also fevers which arise from choked drains, cess-pools, and so forth, concerning which we have heard so much of late, and of which I shall have to speak more at length presently. It seems probable that these fevers are not contagious, and that they should not be so seems to me in accordance with the deductions of theoretic reasoning, anterior to all experiential evidence; for the poisons on which they depend are formed by chemical causes, acting on dead matter exterior to the living body; and although the poison thus generated may and does gain access to the blood, and by that means excite certain conditions in the system, to which we give the name of fever, still it is not probable, nor does it seem to be the fact, that this product of dead matter shall find any material in the living blood by means of which it can multiply itself, so as to form a fresh supply of the same poison. Now, this is surely a very important distinction to bear in mind while studying these diseases,—that the poisons of the contagious fevers are formed in the living blood, and hence find the materials

of increase in that fluid, so that one individual affected with any of these diseases coming into a healthy town or neighbourhood, may be the means of extending the malady to thousands; while, on the other hand, a person labouring under a fever, the origin of which had been external to the living body, on thus coming into a healthy district, injures no one; the poison which affected him, not having been a product of the living body, does not find in his body the necessary elements for its reproduction, therefore ceases with himself.

It will be observed in what I have said under this head, that I have assumed that typhus does, in common with small-pox, measles, and scarlet-fever, possess the peculiarity of only occurring once during life. I now have to show some of the grounds of this assumption. The evidence is the same in kind, and nearly equal in amount, to that on which the same fact rests as regards the other diseases mentioned. It is not professed that a second attack of typhus never occurs in the same individual, but that it very rarely does so, in comparison with the number of persons who are exposed to the contagion of typhus, after having gone through one attack.

The first evidence I will adduce is furnished by, as far as I know, the first propounder of the doctrine, Dr. Perry, of Glasgow. His paper consists—first, of the grounds on which he claims to be heard in the matter, these being the careful observation of upwards of four thousand cases of the disease; and secondly, sixteen carefully elaborated propositions deduced therefrom.

The eleventh proposition is the following:—That contagious typhus is an exanthematous disease, and like small-pox, measles, and scarlet-fever, during its course, produces some change in the system, by which the individual having once undergone the disease, is (as a general rule,) secured against a second attack, and may with impunity expose himself to the contagion of typhus, if he continues to reside in the same country in which he previously had the disease. In those cases which are exceptions to the general rule, the disease appears in a mild and modified form."*

Dr. Davidson, in the essay already referred to, says:—"The following table shows the answers to questions which were carefully

* *Edinburgh Medical and Surgical Journal*, vol. xlv.

put to patients which were admitted into the Glasgow Fever Hospital, from November 1st, 1838, to November 1st, 1839. It includes the whole of the patients affected with eruptive typhus, from whom answers were obtained relative to any former affection with fever, as evidence from decided cases only could be made available in the elucidation of this point:—

	MALES.	FEMALES.	TOTAL.
Not previously affected, ...	284 ...	251 ...	535
Previously affected, ...	33 ...	41 ...	74
			609

This table shows that out of 609 eruptive, or decided cases of typhus, there were only 74 persons who stated that they had previously laboured under fever."*

The above table furnishes strong evidence in favour of the proposition I am maintaining, as there were only 74 persons out of 609 who had previously suffered under fever of any kind; and when it is considered how generally the different kinds of fevers are confounded one with another, it will appear exceedingly probable that a very small proportion, even of the 74, had previously suffered under the maculated fever. And when it is further borne in mind that the table gives all the cases of eruptive typhus that were admitted into the Glasgow Fever Hospital during one year, and that typhus is almost never absent from that city, it will appear somewhat more than a coincidence, that among the admissions to the hospital, the second attacks should have borne so small a proportion to the first.

The last statement upon this point with which I will trouble you, is from the paper already quoted, in the second number of the *British and Foreign Medico-Chirurgical Review*:—"Of the many second attacks that we have witnessed, in the way of relapse, during the epidemic of last year, we never noticed all the specialities of maculated fever to be twice displayed. Still, that fully-developed instances *may* be exhibited in the same individual more than once, analogy would not permit us to doubt, even though there were no correct evidence upon this point. Scarlatina is sometimes repeated; we have ourselves twice attended the same child in measles, at an interval only of a year; and Dr. Baron, of Cheltenham, in his

* *British and Foreign Medical Review*, vol. xi.

Vaccination Report, relates authentic instances of *third* attacks of small-pox. And we are confident, that if the distinctive peculiarities of maculated fever were more generally a subject of close observation, immunity after attack would be found to obtain very much in the same proportion, and to be qualified much in the same way, as in the other exanthematous fevers."

This concludes what I think it necessary to say at present concerning the distinctive characters of typhus; and I trust it will be considered that some grounds have been established for the admission of the disease into the class of exanthematous fevers, and thus an important step will have been attained towards the elucidation of what is to follow.

Now there is distinct and unequivocal evidence, that, during the years 1843 and 44, there was a fever which spread extensively in different parts of these islands, which differed in its causes, symptoms, progress, and termination, from that we have been describing, or true typhus, and which there can be no just reason to doubt was a disease as distinct from typhus as small-pox is from measles. I cannot afford the space necessary, in order to detail the grounds of distinction; the leading characteristics were the following:—

1st. The absence of any eruption.

2nd. The short duration of the disease, generally terminating from the fifth to the seventh day.

3rd. The manner of terminating, almost invariably by critical diaphoresis.

4th. The great frequency of relapse, the relapse being the rule, and its absence the exception.

5th. The extreme rapidity of the pulse; the average in thirty-eight cases of the disease, on or before the fifth day, was 123 in the minute, while, in fifteen cases of eruptive typhus, the average was 100 in the minute. (Henderson.)

6th. The small amount of mortality, the average number of deaths not exceeding three per cent. of the attacks.

Lastly. The one disease conferred no immunity from the attack of the other, as there were several cases where the same individual suffered under both diseases within a short period of time. (Henderson.)

There were not wanting those who denied that the two diseases

were distinct; but where is the fact in medicine that has not been denied? The literature of the disease is sufficiently extensive. I may mention a few of the authorities:—Dr. Alison,* Dr. Rose Cormack,† Dr. Craigie,‡ Dr. Henderson,§ Dr. Richard Wardell,‖ Dr. Perry,¶ and Dr. Smith.**

The paper by Dr. Henderson is that to which I would especially refer those who wish to investigate this subject further, for the evidence in support of the essential distinctness between the disease in question and typhus.

I now proceed to discuss as shortly as may be the doctrines set forth by various commissions of inquiry concerning the sanitary condition of large towns, in as far as their reports refer to the origin and spread of fever. It is well known to all those who hear me that the publications in question have proclaimed loudly the doctrine, that typhus is capable of being originated under all kinds of circumstances, and by all sorts of substances, animal and vegetable, provided they be placed under conditions favourable to the process of decomposition: in short, that the dwellings of the poorer inhabitants of our large towns, with their cesspools, their uncovered and stagnant drains, their imperfect supply of fresh air and pure water, and the crowded condition of their inmates, contain within themselves all that is essential for the generation of the poison of typhus. Now this is a doctrine that I can in nowise admit the truth of; and yet it is no light matter to attempt its refutation, as the belief is almost universal. Still it must be borne in mind that the advocacy of numbers, forms a very poor ground for the belief of a doctrine, apart from the inherent truthfulness of the doctrine itself. Man, if I may so speak, is a gregarious animal in the domain of thought, as well as in that of action, and thus a set of notions, supported by some external plausibilities, be it in religion, politics, philosophy, or physic, once set a going, is like a snow-ball which a boy rolls along the street until its size becomes

* *Northern Journal of Medicine*, No. 1.
† A Monograph.
‡ *Edinburgh Medical and Surgical Journal*, vol. lx.
§ *Ibid.*, January, 1844.
‖ *London Medical Gazette.*
¶ *Edinburgh Medical and Surgical Journal*, July, 1844.
** *Ibid.*, January and July, 1844.

too great for him to move, the increase having taken place by the absorption into its mass of various unattached particles of snow with which it was brought into contact; so with a doctrine, which goes rolling along through the world, and in its course meets with vast numbers of unattached minds—that is, minds devoid of definite ideas on the subject thus brought into contact with them; and, like the particles of snow, they give in their adhesion. Nor does the parallel stop here, supposing the doctrine to be erroneous; for, what a hot blast of sunshine is to the snow-ball, free and public discussion is to the doctrine,—namely, the cause of its liquefaction and dispersion.

But, before I enter upon the discussion of this subject, it is important that I should free myself from the probability of misapprehension as to the extent and scope of the remarks I am about to make. It must not be imagined that I have any intention of calling in question the great benefit and advantage, likely to accrue to the health and morals of the lower order of society, by means of the investigations brought about through the instrumentality of a commission of health; on the contrary, it is because I entertain so high an opinion of the good which might result under the operation of a well-conceived sanitary reform, that I am anxious to bring under the notice of so important a meeting of medical men as the present, what appear to me to be grave errors in matters of fact, and a system of loose logic in reasoning on those so-called facts, and drawing conclusions from them, in as far as relates to the subject now under our consideration, namely, the cause of fever. And, further, it is obvious, that if the advocates of sanitary reform in their publications hold out hopes to the public, that under the system of regulations which they propose, one of the most fearful and fatal maladies incident to man in this country will be no more seen in our cities; and if, after trial shall have been given to the plans proposed, the promised result does not follow, the reaction in the public mind will be altogether on the other side, and the good which has been effected will be overlooked in the disappointment at the non-realization of that which was promised. Therefore it is that I am anxious to bring forward evidence which appears to me conclusive, that in the nature of things, after the best sanitary regulations that can be adopted, we shall still be liable to epidemics of typhus in our large cities and

towns, especially those wherein extensive manufactories exist; and that it is Utopian, in the present state of our knowledge, to imagine that anything the wit of man can devise, shall have the effect of banishing typhus from our country, until fluctuations in labour, commerce, and the price of provisions shall cease to exist, and every individual of the community shall be so circumstanced as to have within his power a sufficiency of food and clothing to preserve his body in health and vigour; and then the predisposing causes of typhus, as of nearly all other diseases, will have no existence, and we shall cease to have epidemic diseases, because we shall have no class of our population among whom disease can become epidemic.

It is with some satisfaction that I am enabled to quote the following extract from the Report by the Committee of the Royal College of Physicians, Edinburgh, appointed to consider any bills that may be brought into Parliament for the improvement of the health of towns, and the applicability of such measures to Scotland.* The Committee consisted of Professors Alison, Christison, and Gregory, and Drs. Stark and Spittal. The remarks already made, as well as those which are to follow, were written before the Report came under my observation; some of them, indeed, more than five years ago, before the subject had attracted any great share of public attention; it is, therefore, with the greater pleasure that I give the following quotation:—

"The Committee think it necessary to add, that while they fully concur in the importance of the measures in question, they do by no means indulge in any such sanguine anticipations as to their immediate consequences, as are contained in the Report of the Committee of the Health of Towns' Association, in London, and in other recent publications; and they consider this a point of great importance, because, if the public are led to form such expectations of the result of these measures as cannot be realized in practice, the necessary consequences must be,—*first*, that other measures, which may be equally necessary for the health and comfort of the inhabitants of towns, may be neglected; and *afterwards*, that a little experience of the state of the public health, after other measures shall have come into operation, may cause a general and hurtful feeling of distrust as to the principles on which they are founded. Thus, there is a great risk of the real efficacy of such measures being first overestimated, and afterwards undervalued, in both cases to the public disadvantage.

"In particular, the Committee cannot concur in the statement (at 10 of the Report above quoted,) that 'science might secure to the whole population of this country such sanitary measures, involving protection from disease, suffering, and premature death, as are actually extended to the inmates of well-regulated prisons;'

* *British and Foreign Medico-Chirurgical Review*, April. 1848.

where, be it remembered, the diet, clothing, and whole mode of life and intercourse with the rest of the community, are completely under the power of the authorities regulating those institutions.

"The members of this Committee have witnessed too many and too extensive epidemics of fever, and are too well aware of the varying circumstances under which these may be diffused, to entertain any expectation that, by all the sanitary measures here proposed, such epidemics can be prevented from recurring occasionally; or their symptoms and mortality from varying, as they often do, in all ranks of society; or their extension among the poorest people, who will inevitably crowd together, particularly in cold weather, in rooms, the atmosphere of which will necessarily become foul and offensive, be controlled as in a barrack or prison. They very much doubt whether the 'slaughter of the living by the dead,' *i. e.*, the extension of epidemic disease by the retention of dead bodies in inhabited houses, has been a material cause of the propagation of fever in the great towns of Scotland, which are known to have suffered much more from this cause than those in England. And they cannot concur in the general and unqualified assertion, that 'wherever animal and vegetable matters are in a state of decomposition, a poison is generated,' capable of producing fever or other epidemic disease. If this last assertion had been correct, there are many parts of this town in which such diseases would constantly prevail, or at least, always be apt to affect strangers taking up their abode there; whereas it consists with the knowledge of this Committee, that there are no parts of the town constantly liable to such diseases; that although these spread most rapidly and most extensively in the filthiest and worst-aired parts, yet, even in these, they prevail only occasionally; and that when they do prevail, their origin may generally be traced to *importation* from places previously affected, and their extension to the effluvia arising from the *living subjects*, applied directly, or indirectly, to those who become successively affected.

"All that these sanitary measures can effect will not purify the air of the interior of the crowded rooms, inhabited by the dissipated and improvident poor, or by the destitute poor; nor do more than diminish the variety of disease and suffering, which may be ascribed in part to the impurity of that air. And although much may be done by religious and moral instruction, by an enlightened and general system of *improved secular education*, especially as addressed to those who stand most in need of sanitary improvement, and by a well-regulated relief of destitution, to correct the evils which spring from dissipation or from indigence; yet it is only necessary to advert to the great mass of suffering, permanently included under the name of the Irish Poor, in every large town in this country,—to the effects of stagnation of trade in any of the manufacturing districts,—or to the faulty construction of large portions of such a town as this, which are private property, and cannot be rapidly altered,—in order to perceive that any such measures, for a long time to come, can only be partially successful.

"But if the public expectation, as to the effect of these measures, be not raised above a reasonable height; if it be only affirmed that the health of all towns may be gradually, but materially improved; the extension of epidemics in them be restrained; the probability of life, even in large and ill-situated towns, be very considerably increased; and the comfort and happiness of all classes of the inhabitants be materially promoted—the Committee have the greatest pleasure in saying, that they think all these benefits may be confidently anticipated from these measures.

(Signed) "W. P. ALISON, Convener."

The value and importance of the above views must be the excuse for the length of the extract. I need not say anything as to the claims of the Committee to the respectful attention of the medical profession.

I now pass on to consider, as shortly as I can, some of the statements published by the Health of Towns' Commission, First Report, "On the Causes of Disease, and the Means of Prevention," published in 1844. The first person examined was Dr. Southwood Smith; at p. 19, the following question is put to him:—

"You have attached considerable importance to the subject of sewerage, so much as to state that you would be able to indicate the fever-localities by the presence or absence of sewerage. Do you mean by that to assign as a principal cause the absence of sewerage, not, of course, saying it is the sole cause?"—*Answer.* "I conceive the immediate and direct cause of fever to be a poison generated by the decomposition of animal and vegetable matters."

At p. 123, Dr. Duncan, of Liverpool, says:—"Further, it has been observed that when a poor population is densely crowded, a kind of poisonous matter, of a highly contagious character, is generated in the system, affecting with typhus and other fevers, not only those in whom it first originated, but spreading with rapidity amid such a population, from individual to individual, from house to house, and from street to street." The author had been speaking previously of decomposing animal and vegetable matters.

Now, I may observe that the modes of origin of typhus, here spoken of by Dr. Smith and by Dr. Duncan, although at first sight they may appear the same, are in reality entirely distinct and opposed. Dr. Smith conceives the poison to arise from the decomposition of animal and vegetable matter, that is external to the living body. Dr. Duncan speaks of the poison as generated *in* the system. In a former part of this Address I made some remarks on what I believe to be the importance of this distinction.

I now go back to page 3, Dr. Southwood Smith being the respondent. Speaking of what he terms "fever-districts," he says, "The fever-districts of the metropolis are situated in different parts of it; and it is in accordance with ordinary experience to find fever raging in some of these districts at the very time that others are enjoying a temporary immunity from it. In former years I have found, on my personal examination, some localities

in which there was not a single house in which fever had not prevailed, and in some cases not a single room in a single house in which there had not been fever. I observed this particularly in certain localities in Bethnal-green and Whitechapel. Now, during the present year, there has been a very remarkable absence of fever in these, its ordinary seats, while in other districts it has been more than ordinarily prevalent."

"Did you attribute that, in those districts, to bad drainage, or want of water, or some cause of that kind?"—*Answer.* "In every district in which fever returns frequently, and prevails extensively, there is uniformly bad sewerage, a bad supply of water, a bad supply of scavengers, and a consequent accumulation of filth."

Now, although Dr. Smith's answer does not contain a direct reply to the question, still there can be no doubt but that he meant his answer to be taken as an affirmative; let us, therefore, inquire if facts and theory are not somewhat at issue. Dr. Smith states that different districts of the metropolis furnish the fever-cases of different epidemics, and not always the same districts. How does this come to pass, on the supposition that these districts contain within themselves all that is essential for the generation of typhus? The draining and ventilation remain unchanged, the decomposition of animal and vegetable matters goes on as before—why has the effect ceased to follow its presumed cause? It will not do to answer that the epidemic constitution is wanting, its presence, whatever it is, being proved by fever being epidemic in other parts of the metropolis; for I presume no one will argue for the existence of such an epidemic constitution in one part of London, and its absence at the same time in another part. Now this, which seems to me an inexplicable anomaly, on the supposition that the opinions of Dr. Smith are correct, is, on the other hand, confirmatory of the views I am endeavouring to maintain; for all other things are inert towards the origination of typhus until the specific contagion is applied, and the same district is not liable to be the seat of epidemic fever twice within a short period of time, because the same individual is not, for the most part, subject to more than one attack during life; and it would, therefore, require some time to bring into a limited district a sufficient number of fresh subjects to furnish the materials of a second epidemic in that district, even supposing the specific poison to be introduced, or to spring up there.

At page 109, Mr. Liddle is being examined; he says:—"How the sewers can benefit the health of the poor living in the courts and alleys, I am at a loss to conjecture. The poor are still exposed in the same degree to the pestiferous emanations of the overflowing of cesspools, decayed animal and vegetable matter, and stagnant water, which circumstances are proved, by direct experiment, to be the cause of fever; and without some legislative measures are speedily adopted to remove these evils, another epidemic similar to the one of 1838 will, ere long, make its appearance."

This evidence was given in 1844, just six years after the epidemic of 1838. During those six years the inhabitants of the district in question had been living under constant exposure to the above-mentioned impurities, without any epidemic fever appearing; nevertheless, Mr. Liddle attributes, by implication, the epidemic of 1838 to these impurities, and is prepared to attribute any subsequent epidemic that may arise to the same cause. Yet it appears to me that it would be much more in accordance with the principles of sound reasoning, to reject that which is constant and invariable (the impurities mentioned,) in an attempt to fix on the cause of an event (epidemic fever,) which occurs only occasionally, many years elapsing between its visitations.

At page 113, the following question is put to Dr. Aldis:—"What are the chief species of disease you find in the dispensaries, most commonly attendant on the physical circumstances, or upon the atmospheric impurity caused by filth, decomposing animal and vegetable matter, and defective ventilation?"—*Answer.* "The regularly recurrent diseases are fever-cases, inflammatory affections, and derangements of the intestinal canal. When heat and moisture prevail, I anticipate the occurrence of febrile diseases in various forms. In one place, the same general state of weather will be attended with ordinary fever; in another place, at the same time, with small-pox."

Here we have the same evidence, in kind and degree, in favour of small-pox being an effect of local impurities, as that fever is, yet I presume there are but few who would choose to affirm the truth of the former proposition, and therefore it would be more just to say, that the local peculiarities caused neither disease, but predisposed to both.

Dr. Duncan, in his report "On the Health of Liverpool," an

extract from which has been already given, maintains a somewhat modified view of the subject under consideration, though with some reservation in favour of going the whole length with Dr. Southwood Smith. Dr. Duncan seems to entertain no doubt but that bad drainage and ventilation, combined with an over-crowded population, are sufficient for the generation of contagious typhus; one argument in support of which view he draws from the fate of the sufferers in the black hole of Calcutta, and contents himself with the somewhat vague quotation, that the twenty-three survivors "were said to have been afterwards attacked with a fever analogous to typhus." Now, although I consider the evidence drawn from the black hole of Calcutta, and also from the African slave-ships, to be valueless in this discussion, because I am not aware that it has been shown that true typhus ever occurs in hot climates, still, if the argument had any weight, it would, I presume, tell on the side I am advocating, as it has been shown by Dr. Bancroft and others, that neither the survivors of the black hole suffered from any disease at all similar to typhus, nor that the unfortunate captives of the African slave-ships are subject to any such disease.

At pages 134–5, Dr. Duncan has the following:—"It is still a disputed question among the medical profession, whether the malaria arising from the accumulation of filth from decomposing animal and vegetable matter, such as the contents of ash-pits and cesspools, is sufficient in itself to generate fever. Although there are numerous recorded instances in favour of the affirmitive, and many high authorities support that side of the question, I am myself inclined to doubt whether this is an efficient cause of fever, independently of other circumstances. But there is no difference of opinion as to the most important point in this inquiry, *i. e.*, as to the fact of these exhalations favouring, in the highest, the extension of the disease when it has once appeared in a locality where they abound. It is admitted on all hands that, although this condition may not suffice to originate fever, it invariably promotes its rapid extension." I need hardly say that I fully concur in the doubt here expressed by Dr. Duncan.

There have been cases of the so-called origination of typhus, from local causes, put on record so recently as last July, in the *Journal of Public Health* for that month, by Dr. Watson, of Liverpool, in a paper entitled "Instances of the Origin of Typhus

Fever from Defective Sanitary Condition." I feel constrained to make a few remarks on this paper, because the statements are put forth as indisputable facts; and those who do not receive them as such, are looked upon as "persons who have not directed their attention peculiarly to sanitary investigations;" and further, "that it is to deny the whole evidence on which the fabric of medical science rests." The fever is said to have been spotted typhus, therefore, coming within the definition of typhus, which I have already endeavoured to establish. Now, notwithstanding all the confidence with which Dr. Watson has expressed himself concerning these cases, a few words will, I think, suffice to show that they are very inadequate for the support of the doctrine in question. The two cases occurred at the house of a baker in the outskirts of Liverpool; the one in June, the other in September, 1847. There are few occupations more calculated for bringing the individuals who follow them into frequent intercourse with others than that of a baker. This position I need not illustrate. Now, what was the condition of Liverpool at the time these persons were seized with fever? In the summer quarter of 1847, the very time referred to, there were registered 2,227 deaths from fever, and 1,700 cases at once were supplied with hospital accommodation; while, at the same time, about 6,000 were estimated to be under medical care at their own dwellings. And yet Dr. Watson thinks it necessary to hunt up a foul drain to explain why two bakers, at an interval of three months, shall suffer under typhus.

In the commencement of this Address, I stated that the question concerning the cause of fever had been much complicated by the introduction of a popular element into the discussion,—that is, by disquisitions on the subject, by men whose education and habits of thought had not been such as to qualify them for the due appreciation of the elements out of which a judgment has to be formed. The fourth number of the *Journal of Public Health* furnishes a striking example of this fact. Mr. William Lee, an engineer, of Sheffield, has written a paper on typhus fever in rural districts. Mr. Lee, after stating that typhus and other forms of febrile disease generally have an efficient local cause, goes on to say, that "To ascertain these causes of disease, requires a considerable amount of constructive skill and experience of engineering, chemical, geological, and other scientific attainments, quite distinct

from pathological inquiries." These are great words, but they have no meaning; for I have yet to learn that the cause of any disease with which we are acquainted, has been discovered by means of any, or all of the above-mentioned qualifications, apart from their connection with pathological knowledge. The facts furnished by Mr. Lee are much of the same order as we generally meet with. Fever exists in a locality; something offensive is found near at hand, and that is put down as the cause of the fever.

Before quitting this part of my subject, I may call attention to a very able article in the eleventh volume of the *British and Foreign Medical Review,* wherein the earlier reports on the sanitary question are passed under review, and a kind of argument adduced against their conclusions, which I have not touched on, not because I do not consider it an important argument, but because it has been so fully insisted on in the article referred to. It is chiefly drawn from the writings of Parent Duchatelêt, regarding Montfaucon, near Paris, where there exists, perhaps, a greater amount of decomposing animal matter than in any other place in the world, and yet no fever occurs among the work people engaged there, nor among their families, who live in the immediate neighbourhood. This is good negative ground for denying the potentiality of such causes elsewhere, and, so far as I know, has never been properly met by those who take an opposite view of the question.

Now, it will be observed that I have spoken throughout this Address of one form of fever, the characters of which I laid down at starting, and it is the power of originating this form alone that I have denied to be possessed by local and occasional causes. That there are febrile disorders capable of being produced by local causes I do not entertain any doubt; all I deny is, that any such disease, of undoubtedly local origin, ever possesses the characters of true typhus. With those who hold a contrary opinion properly lies the burthen of proof: but something more in that way is required than the vague statements, some of which have been passed under review in the last section of this paper.

Professor Christison has described, in the first number of the new series of the *Monthly Journal of Medical Science,* the most clear and unequivocal example of febrile disorder, arising from a local cause, with which I am acquainted. The original paper is

so easy of access to all who take an interest in the inquiry, that I shall merely state some of the leading facts connected with this very interesting narrative. The disease broke out in a farm-house, in Peebleshire, in a thinly-peopled rural district, far from any other dwelling, and as favourably situated for the purposes of health as it well could be. The number of individuals who suffered under the malady was fifteen, which included all those who either resided in the house, or had occasion to be much in it during the day; six of the number resided night and day in the house, and these, without exception, suffered most severely from the disease; three of the six cases proved fatal, while none of the remaining nine, who slept out of the house, died. In neither of the cases did any eruption on the skin exist, such as has been spoken of as characterizing typhus. Nine of the individuals who suffered under the disease, lay, while ill, in cottages remote from the farm-house, but in no instance did those in attendance on the sick, who did not frequent the farm-house, suffer under the malady.

The peculiarities of the disease are pointed out in the following words by Dr. Christison:—"It appears that in the whole fifteen cases, the symptoms in their nature and succession were generically the same, and with but few specific peculiarities in each. The leading symptoms were those of great gastro-intestinal derangement, nausea, vomiting, loathing of food, an excessively loaded tongue, and obstinate constipation; the accompanying fever was slight, and in its type adynamic. Exhaustion of the nervous system, without any particular cerebral oppression, except in the single case of the servant girl, was the principal consecutive danger incurred; and in no case was there detected any trace of the petechial eruption, so general for some years past in the infectious typhus of this country."

Dr. Christison says, regarding the first case he saw:—"I was struck with the physiognomy of the disease, as presenting something very different from that of ordinary infectious typhus at the same stage, the countenance being pale, the eye lively, the expression natural, and by no means oppressed, the mind clear and alert, and the strength far from so prostrate as it is usually observed in early convalescence from our late epidemic typhus."

In only remains to state, as regards the cause of the disease, that on examination, the house-drains were found completely

choked, and that on their being opened, an intolerable effluvium was perceived by those around; for the evidence that the choked drains were the cause of the disease, I must refer to the original paper; it is sufficient to satisfy my own mind. As regards Dr. Christison's paper, I may remark that it has lately been referred to by Dr. Guy in support of the local origin of typhus; whether he or I have given the truest account of the bearing of the facts detailed in that paper, I must leave to others to decide.

In a paper by Dr. Hudson, "On the Poison of Fever," several instances are noticed from the writings of Drs. Christison, Cheyne, Addison, Armstrong, and others, and also some that had come under his own observation, where there were good grounds for believing that a febrile disorder had arisen from a local cause; but in none of these cases does it appear that any eruption on the skin existed, or that the disease spread by means of contagion. I am prevented, by want of space, from citing any of these cases at length.

I stated, in a former part of this Address, that at its conclusion I would return to the question, whether typhus ever spreads in any other way than by contagion. We shall never be in a position to discuss this subject with advantage, until medical men, in their reports on fever, shall agree as to the distinctive characters of different fevers; until the practice ceases of calling every disease that presents a quick pulse, a hot skin, and a dry tongue, fever, or typhus, or continued fever, according to the whim or habit, or any other like motive, of the writer.

It is not the object of my remarks to attempt to prove that typhus never arises in any other way than from pre-existing contagion; for, if the existence of the disease could be traced ever so far back in the history of the world, still it must, at one time or other, have had a commencement; and we are not justified in denying that the same causes that were sufficient to originate the poison of typhus, in the first individual of the human family that ever suffered under the disease, may in our own day come into operation. In this particular, typhus occupies precisely the same ground as small-pox, measles, and scarlet-fever; and, however interesting such speculations may be, they are not of much importance to the practical physician. He wishes to ascertain the

causes on which the spread of such maladies in the epidemic form depends, and he finds that while there are numerous circumstances which predispose the individuals of a community to fall into disease—such as insufficiency of food and clothing, depressing passions of the mind, and impure air, still, that the only exciting cause worthy of his attention, is the communication of the disease from the sick to the healthy, and therefore that there is no immediate object so worthy of his attention as the early separation of the sick from the healthy; and next to that, it becomes his duty to devise means for the removal of the predisposing causes. But it is a fatal mistake, if he thinks this has been acomplished when he can enter the dwellings of the poor without offence to the delicacy of his olfactories. He has then only effected the removal of one out of many evils; and but little good will follow in his steps if he leaves behind him, unmitigated, the hopelessness of destitution, with its physical and mental depression. It seems to me little better than a mockery to talk to a man about pure air when he wants bread. The room he lives in, and not the man, seems to be the grand object of the present day. Now I would have the condition of the man attended to first, and his room afterwards.

In concluding a paper, the object of which is an inquiry into the causes of an important disease, it cannot be out of place to remind the members of the medical profession of the first rule of philosophising laid down by Newton,—"Causas rerum naturalium, non plures admitti debere, quam quae et vera sint, et earum phænomenis explicandis sufficiant."

The foregoing paper having been arranged chiefly with reference to its delivery in the form of an Address, is not so complete in its evidence and illustration as the Author could desire, on submitting it to the profession in the published form. It is therefore his intention to publish an Appendix in the next volume of the *Transactions*, which shall furnish such further materials as he deems requisite to a full exposition of the subject of the Address.

W. D.

A

BIOGRAPHICAL NOTICE

OF

EDWARD HOLME, M.D., F.L.S., &c.

BY WILLIAM CHARLES HENRY, M.D., F.R.S., F.G.S.,

Corresponding Member of the Royal Academy of Sciences of Turin, and of the Archæological Institute of Rome.

READ AT THE ANNIVERSARY MEETING

OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION,

HELD AT BATH,

ON WEDNESDAY AND THURSDAY, AUGUST 16TH & 17TH, 1848.

DR. HOLME was one among those "who are mentioned with reverence, rather for the possession than the exertion of uncommon abilities." Whether from a severely fastidious taste, which he was unable to satisfy, or from his mental tendencies impelling him rather to accumulate knowledge than to extend its boundaries, he has left to the world no measure of his intellectual stature. His only printed composition, besides his *Inaugural Thesis*, is a brief note on the correct reading and right interpretation of a partly effaced Roman inscription. It was, therefore, in social intercourse, and especially in the form of animated discussion, that his boundless knowledge and extraordinary mental power were chiefly manifested; and his fame, earned by such conversational efforts, can be expected neither to extend far beyond the circle of his friends and contemporaries, nor to outlive their remembrance. It has been judged the more expedient to attempt some permanent record, however imperfect, of one who, during upwards of half a century, filled so large a space in the higher intellectual life of the community among whom he resided;—a founder of one, the highest office-bearer of all its local institutions dedicated to letters and science, and the steady, zealous, and consistent friend of all liberal and elevating studies.

Edward Holme was born February 17th, 1770, at Kendal, in that northern part of our island, which has ever proved singularly fertile of robust and masculine intellect, and which gave birth to his greater fellow-townsman, Dalton. He inherited from his father the small estate of Cracalt, which had been in the possession of his family for several generations, and which furnished him with a moderate maintenance during the long years of medical probation. Thomas Holme, the father, combined with the cultivation of his patrimonial fields the business of mercer and retail trader in Kendal, an association not uncommon even now in small towns in the north of England. No notices have been preserved of his early studies beyond an impression, which I have been unable to authenticate, that he had been the pupil of Mr. Dawson, of Sedbergh. In January, 1787, he was admitted, at the age of nearly seventeen, a student in the Academy, that had been recently established in Manchester, and in the same month is the first record of his having attended, with his father, a meeting of the Philosophical Society. It appears from the College Register, that he had already made choice of medicine as his future profession, and that he quitted the Academy in June, 1789. It was either at this period, or while still a student at the Academy, that he became an inmate in the house of Dr. Percival, who, from constant liability to intense head-aches, and from a peculiar susceptibility of the nerves of the eye, at times threatening loss of sight, was compelled to have recourse to the services of a reader and amanuensis. These offices were fulfilled for some time by Dr. Holme, who received in return invaluable counsels and wise guidance in his studies from that elegant scholar and singularly learned and skilful physician. He has himself expressed his deep sense of obligation to Dr. Percival, for these acts of kindness, as well as for his medical care of him during a severe illness, in the dedication of his *Thesis* :—

"Viro celeberrimo Thomae Percival, M.D., S.R. & A.S.S., Lond. & Edin., &c., &c., &c. A quo in se amore paterno collata beneficia semper gratus agnoscet, cuique praeter alia innumerabilia sibi praestita officia, salutem debebit, quam olim felici artis exercitio aliis adlaturus sit, specimen suum inaugurale ea, qua, par est, reverentia atq. obsequio D.D.D. Auctor."

In the summer of the year 1790, he left Manchester, with two young German friends, for the University of Göttingen, where he

doubtless laid the foundations of his varied and accurate scholarship, and where he enjoyed the inestimable privilege of sitting at the feet of Heyne. He was especially attracted by the lectures on "Ancient Art," which Heyne, stimulated by the laborious researches and lofty eloquence of Winckelmann, had first introduced into the course of academic teaching. We are told by Heeren,* that it was more in these oral discourses than even in his published Essays, that Heyne displayed the vast extent of his archæological studies. The rough notes he had collected, as the suggestive material of his extempore lectures, filled thirty-two large portfolios, and were gathered from the entire domain of "Ancient Art." Dr. Holme was an earnest hearer of these impressive lectures, to which he often referred in after-life, as having essentially moulded his early tastes and habits of study, and had preserved full notes of them, which have been found in his library written out in German, and superbly bound in two volumes. He ever retained a deep interest in those studies, to which the term archæology is now specially restricted by some German scholars—a limitation of meaning obviously not warranted by its etymology. They supplied the subject of an Essay "On the History of Sculpture, from the earliest period to the time of Phidias," which he read in 1816 before the Literary and Philosophical Society, but declined publishing in its *Transactions*. At Göttingen he acquired a thorough mastery of the German language, and became intimately conversant with the writings of Lessing, Winckelmann, and Wieland. In after-life he showed a decided preference for this earlier age of German literature, and, indeed, could scarcely be said to be familiar with the creations of the two mightier spirits, to whom Germany has since given birth.

There are no traces of his professional studies at Göttingen. In the winter of 1791–2 he removed to Edinburgh, where it appears, from the University Register, that he attended the classes of anatomy and surgery, practice of medicine and clinical medicine, then taught by Dr. Monro and Dr. Gregory. In the following year, 1792–3, in addition to the same courses, he studied chemistry under that impressive teacher and great philosopher, Dr. Black. He was accompanied to Edinburgh by Dr. Percival's second son, Mr. James Percival, who died in February, 1793, of a malignant

* *Chr. G. Heyne*, pp. 193 and 213.

fever, during which he was watched over by Dr. Holme with "affectionate and assiduous attention."

Dr. Holme received the degree of Doctor in Medicine, at the University of Leyden, in December, 1793. His *Thesis, de Structura et Usu Vasorum Absorbentium,* in sixty-one pages, a monument of industrious research and critical judgment, contains a complete and masterly exposition of all that was then known of the anatomical structure and distribution, and of the functions of that system of vessels. It appears to have been drawn in considerable measure from the lectures of Monro Secundus, of whom he makes frequent and honourable mention.

Early in the year 1794, he commenced the practice of medicine in Manchester, influenced in his choice, probably, by the advice and encouragement of his steady friend, Dr. Percival. In April of the same year, he was elected one of the physicians to the Infirmary and the other charities, associated under the same medical officers, an appointment which he held till the year 1828.

His medical career in Manchester formed no exception to the general rule of tardy admission to the emoluments of the profession. Indeed, he had made so little progress, after twenty years, as to have real cause for bitter complaint of ill success and for feelings of despair as to the future, which he often poured forth, in the confidence of friendship, to a brother physician.* But after the death of Dr. Ferriar, early in 1815, he rose rapidly into notice; his services were more and more sought for, and he attained and preserved an extensive and lucrative practice.

During this long probationary period, Dr. Holme resided in lodgings, in which, for about seven years, he enjoyed the companionship of the late Mr. Benjamin Heywood Bright, a person of extraordinary mental power and profound literary acquirements. Mr. Bright was especially learned in curious and recondite branches of letters, was a successful collector of scarce books and manuscripts, and had gathered together whatever could throw light on our earlier dramatists. It was from him that Dr. Holme imbibed a taste for such pursuits; and he is believed to have been mainly indebted to Mr. Bright for the amount of bibliographical knowledge which he acquired—vast in the estimation of the uninitiated, but it would appear, only respectable in that of more competent judges. Their

* The late Dr. Henry.

love of curious books, and their healthful vigorous tone of thought and frank manly bearing, rendered both the friends peculiarly acceptable to Dr. Parr, who became their guest, whenever he visited Manchester. There are no traces of any active correspondence having been maintained between Dr. Holme and this illustrious scholar.

Dr. Johnstone, in his life of Parr,† observes,—"I lament that I have been unable to extract from my learned friend, Dr. Holme, of Manchester, any account of his correspondence and connection with Dr. Parr, who has left many records of his personal respect for him, and his estimation of his great learning and talents. Dr. Holme had twice a full opportunity of appreciating Dr. Parr from near view. Parr visited him for a long time, and Holme was duly impressed with veneration for his talents, esteem for his virtues, and gratitude for his instructions and kind attentions." Only two letters from Dr. Parr have been found among Dr. Holme's papers. In one, consisting of directions about returning a book "carefully, most carefully packed up—be very careful, do not spare paper, nor sealing-wax, nor yet packthread," Dr. Parr addresses his correspondent as "My learned, my truly excellent, and deeply reverenced friend." In the second, dated Hatton, January 19, 1820, Dr. Parr thus makes mention of a journey to Kendal, where he had been cordially welcomed by Mr. Richard Holme:—"I was much pleased with the sterling good sense and unartificial manners of your uncle. Did he tell you that he favoured me with his company to Kendal Church; that we were seated near the Corporation; and that by a fatality distressing to him, but amusing to me, the Athanasian Creed formed a part of the service; and that with genuine schismatical stiffness he did not stand up during the recital of the orthodox and mystical formulary." We are, fortunately, also in possession of two letters from Miss Holme to her brother, in which she describes this memorable visit, and Dr. Parr's friendly though familiar eulogy of Dr. Holme. "Some people buy books to look at; *Ned* buys them to read. I love Ned; I have him here," putting his hand to his heart. Speaking of his eldest daughter, he said, "She was one of the finest women in England; I educated her myself." Uncle Richard replied, "Then you have made her liberal."—Dr. Parr, "I have made her a Christian, Sir." It is worthy of mention that Miss

† Dr. Parr's Works, vol. 7, p. 605.

Holme reports that Dr. Parr, as well as her uncle, remained sitting during the reading of the Athanasian Creed.

In this earlier or initiative period of Dr. Holme's career in Manchester, it is the impression of Dr. Hibbert Ware, one of his oldest surviving friends, and from kindred tastes, and even profounder attainments in science and in antiquarian research, peculiarly qualified to pronounce judgment, that his favourite studies, out of the pale of his profession, were history and the philosophy of history. "As an historian, he appeared to be an omnivorous animal; nothing came wrong to him, from the history of civilization in Greece and Rome to the long disputes of Whig and Tory, and even to the local details of Jacobite contests in Lancashire, or to genealogical questions of the least possible import in the same or adjoining county of Cheshire. In a paper read at the Philosophical Society, in which the author had occasion to advert to the different views, entertained on the origin and design of the Eleusinian and other mysteries, Dr. Holme exceedingly gratified and instructed his hearers, by the able manner in which he reviewed the questions long agitated, particularly by Warburton, in his *Divine Legation*. Several times I have met him at dinner parties in his younger days, but I do not recollect that the subjects, which rendered his company so fascinating and instructive to the then rising generation, varied from questions, arising out of the study of history in its reference to any period and region. For instance, when Roscoe and Shepherd, of Liverpool, made Italian history and the history of the revival of literature in the middle ages so fashionable, Dr. Holme's postprandial disquisitions resembled so many prelections. With his remarkable memory and extensive historical research, combined with a most perspicuous mode of expression, he often left his hearers gratified in the extreme. Lastly, I well remember a remark he made in my younger days, which has made a lasting impression upon me. In answer to some eulogium on the standard historians of those days, such as Hook, Robertson, Gibbon, or Hume, 'I am satisfied with none of them,' said Dr. Holme; 'a time will come when it will be found necessary to write what are now considered our best histories entirely over again; if we of the present day are satisfied with them, depend upon it posterity will not be so complying.' From this remark you will

easily perceive that he was only anticipating such histories, as now find acceptance, where very different solutions are proposed to explain the different phases, which civilization has manifested in its progressive development. In his earlier days he could only have a prophetic glimpse of labours like those of a Niebuhr, an Arnold, a Guizot, a Ranke, or a Thierry." "Dr. Holme gave a preference to those historical inquiries, which were directed to the civil and political circumstances of nations, and only in a subordinate degree to their ecclesiastical state. He had applied himself to a profound study of the civil constitution of England. * * * I know that he had studied ancient mythology, whether among the polished nations of the south east of Europe, or among the northerly Germans, Scandinavians, and Saxons."

Dr. Holme always manifested a lively interest in all matters of antiquarian research, which happened to fall under his observation. He had become the possessor of an ancient stone cross, which had been found beneath the soil of St. Mary's church-yard, in Lancaster. On this cross, was a brief Runic inscription, respecting which he made an interesting communication to the Philosophical Society in November, 1838. I have found among his papers some rough notes, written on the backs of letters, and loosely heaped together, like the leaves of the Sybil, which constituted, probably, the materials of this extempore address, and had never been digested into a more permanent form. It is, however, the conviction of Dr. Hibbert Ware, that Dr. Holme never became an accomplished archæologist, and that he pursued these studies, not so much for themselves, as for the invaluable light they throw on purely historical inquiries. There were, however, some special branches of the comprehensive science of archæology in which, for a physician in large practice, he had made decided proficiency. "He had studied with the liveliest interest the best county histories, and was minutely learned in Ormerod's *Cheshire*, and in Dr. Whittaker's *History of Whalley and the Valley of the Lune*." This reading had brought the subject of heraldry and genealogy before him, and, continues Dr. Hibbert Ware, "During some of the very latest occasions when I met him, about two or three years ago, he quite surprised his hearers with the extent of his memory on some very dry and highly complex discussions of this character, which with great ability and adroitness he contrived to unravel."

Dr. Holme became a Corresponding Member of the Literary and Philosophical Society, November 1st, 1793, and an ordinary Member the following spring. He filled in succession all its offices of honour, having been elected one of its Vice-Presidents, October 23, 1797, and every subsequent year till 1844, when, on the death of Dr. Dalton, he was raised to its highest dignity. The Archives of the Society, in which are preserved the titles of the essays, which he read before it, but afterwards withdrew from publication, furnish interesting evidence of the variety and extent of his reading.

He was one of the most active founders and the first President of the Natural History Society of Manchester, as well as of the Chetham Society, constituted for the object of publishing historical and literary remains connected with the palatine counties of Lancaster and Chester.

His life, passed wholly in Manchester in the active exercise of his profession, and in the uninterrupted pursuit of knowledge, furnishes few materials for commemoration. During the life of his sister, to whom he was warmly attached, and whose letters have been carefully preserved, it was his habit to make an annual visit to Kendal; and after her death, in August, 1830, he continued the salutary practice of seeking relaxation and change of air in a fortnight's excursion during the summer and autumn. I am informed by my valued friend, Dr. Lyon, occasionally his companion on these tours, that it was delightful to witness his freshness and youthfulness of feeling and intense enjoyment of the various little incidents of travel, and how completely, on quitting Manchester, he banished from his mind all professional cares. One principal subject of interest on these excursions arose out of the careful examination of the cathedrals and remarkable churches on his line of route, which, indeed, seems to have been chalked out, chiefly with a view to such visits. He had been early led to the study of ecclesiastical architecture by his intimate acquaintance with Mr. Britton; and I have been informed by Dr. Hibbert Ware, that he had deeply studied the question, much agitated at that time, of the origin of the Gothic arch. A small memorandum book contains full notices, in short hand, of all he had observed deserving of record on these cathedral tours.

He became a Member of the British Association at the Edinburgh Meeting in 1834, and was also present for a few days at Bristol in 1836. When the Association assembled in Manchester, in 1842, he received as his guests, Sir John Herschel and Dr. Faraday, from both of whom letters have been found, expressing the great gratification they had derived from the visit. I am indebted to my distinguished friend, Dr. Hastings, of Worcester, for the following interesting notice of Dr. Holme's connection with the Provincial Medical and Surgical Association:—

"Dr. Holme became a Member of the Provincial Medical and Surgical Association in the year 1834, but he was not present at any meeting of the Association until 1835, when he attended the Anniversary at Oxford, under the Presidency of Dr. Kidd, and was on that occasion chosen President-elect for the ensuing year. In 1836, the Anniversary Congress of the Association was held at Manchester, when Dr. Holme was installed President, and none of those who were present at that meeting, can forget the dignified manner in which he discharged the duties of the office, and the courteous kindness he displayed in his communication with his fellow Associates. He did not appear at that time in good health, and was scarcely equal to the exertion he necessarily had to encounter. At one of the evening meetings, he fainted, apparently from exhaustion. His voice at this time was particularly feeble, and this was an annoyance to him, as he was in consequence a less effective chairman than he otherwise would have been; but the feeling with which all the Members left Manchester was that of profound respect for the President, and they felt convinced, that so long as men of his high moral and intellectual character would take the lead in the proceedings, the Institution would continue to flourish. Upon Dr. Holme's mind the effect seemed to have been most happy. The manner in which he was received by the Members as their President, appeared to make an indelible impression upon him; for from that period till his death he never ceased to take the most lively interest in the affairs of the Society, and was scarcely ever absent from the Anniversary Meetings. Moreover, when a few years after, agreeably to the recommendation of the Council, District Branches of the Association were formed for the purpose of local re-unions, Dr. Holme became one of the most active Members of the Newton Branch of the

Association, of which he was the first President, and constantly assisted, by every means in his power, to make the meetings as efficient as possible for the advancement of medical knowledge.

"He did not often speak at the General Meetings, for his voice being feeble he was not readily heard. Aware of this he generally remained silent; but there were occasions when the lively interest he took in all the concerns of the Society, called him forth, and his remarks were always so pertinent, and were delivered with such simplicity, that they never failed to be listened to by the Members with the gravest attention."

His constitution was uncommonly vigorous, and he enjoyed, till within the last few years of his long life, uninterrupted health. Infirmities, incident to great age, had gradually increased, and had rendered it necessary for him to withdraw more and more completely from the exercise of his profession. He was himself impressed with the conviction, that he had organic disease of the heart. But there seems to have been no ground for this apprehension, and he died, simply from a gradual failure of the vital forces, calmly and without struggle, on the evening of Sunday, the 28th November, 1847, having nearly completed his seventy-eighth year.

Dr. Holme never married, and he left no relatives nearer than cousins. He had acquired a considerable property, upwards of £50,000, of which he bequeathed the residue, after many liberal legacies to relatives and personal friends, to the medical department of University College, London.

Dr. Holme was a member of the congregation of Protestant Dissenters, assembling in Cross Street Chapel, Manchester, and besides a considerable legacy to the Rev. J. G. Robberds, his respected friend and pastor, he bequeathed the sum of £2,000 to Trustees, "for the support and maintenance of the minister or ministers for the time being of that religious body;" and a sum of £1,000 for the same objects at Kendal.

It may be right to add, that he was in politics a firm and consistent whig, and had espoused warmly, and contributed liberally towards, the cause of Mr. Brougham, in the great Westmoreland contest.

Dr. Holme was eminently qualified to excel in the profession

which he had chosen. He was largely endowed with the faculty of exact and vigilant observation, an endowment essential to success in the practice of an art, so purely empirical as that of the physician, who must never aspire to be more than the faithful servant, the unbiassed interpreter of nature. His diagnosis was characterized by breadth, saliency, and direct practical bearing, rather than by that subtle analysis and exact localization of disease, which the French pathologists and their disciples attempt, especially in maladies of the thoracic cavity. Indeed, it was remarkable in so great a reader, that he was by no means minutely conversant with the medical literature of his time, and had decidedly not kept pace with the recent progress of morbid anatomy and pathology in France. But, neglecting these finer distinctions, he bore down at once, with unhesitating sagacity, upon the main features of disease; his interrogatory was concise and strictly relevant, and his practice prompt, simple, and energetic. In prognosis, he was more than ordinarily cautious; satisfied with combating present symptoms, he was ever averse to hazard conjectures or predictions as to the future; and when pressed with such inquiries, he was never at a loss in evading or authoritatively over-ruling them.

It was, unfortunately, not his habit to record and methodize the fruits of his experience. His memory was so tenacious and suggestive, that he could always rely upon its reproducing, whenever required, all past impressions in their original distinctness. He has, therefore, not contributed any insulated cases or systematized observations to swell the stream of medical knowledge. This silence, as to what might have been easily embodied and made permanent, is the more to be lamented, because there is so much in medical experience that is essentially incapable of record or transmission. The faculty of marking at a glance each undefined symptom and faint indication, and of grouping, by a process of thought, so rapid as to seem intuitive, these scattered elements of judgment into a whole; the vigilant eye, the "learned touch," and, we may now add, the cultivated ear; in short, the practised refinements of each and every bodily sense necessarily perish with the individual, and must be slowly acquired afresh by each successive generation. This singular indisposition to original efforts, which we have had occasion to trace, through his entire

mental career, is not easily reconcileable with his extraordinary activity and vigour of intellect; for, as far as it may be safe to judge from *unwritten* demonstrations of great talents, he would certainly seem to have been one who, in the impressive words of Playfair, "might have enjoyed more of the fame, had he been less satisfied with the possession of knowledge."

His attainments in chemistry, and in the physical sciences, did not surpass those of most persons, trained in the best schools of medicine. He could not fail to have imbibed, from the clear and tasteful prelections of his first teacher, Dr. Black, a deep interest in the science of chemistry, then in its infancy, but giving signs of a future vigorous growth. He is also remembered to have been one of the most attentive hearers of a course of chemical lectures, delivered in Manchester, early in this century, by his friend, the late Dr. Henry; but his increasing professional employment, and other more congenial studies, had subsequently engrossed his time, and he had long ceased to keep pace with the rapid march of chemical discovery. The sciences of classification had, at least in later life, greater charm for him. He was elected a Fellow of the Linnean Society, January 15, 1799, his certificate being signed by two distinguished entomologists. Botany, entomology, and ornithology, were the branches of natural history with which he was most conversant. It is the impression of Dr. Hibbert Ware, that these pursuits did not form a part of his earlier studies, but constituted merely the recreation of his later years, after the foundation of a Museum and Natural History Society, in Manchester. If this impression be correct, there is greater reason to admire the extent of his knowledge in zoology, which is pronounced by Mr. Moore, and other competent judges, to have been at once accurate and comprehensive. He was himself one of the most active founders of the Natural History Society, and was zealous in enriching its museum with rare specimens, and in promoting the erection of suitable apartments for their preservation and display. His library was adorned with the most costly illustrated works in natural history; indeed, his dominant passion, the love of books, might be traced in his infinitely greater familiarity with the literature of the natural sciences, than with actual objects and specimens.

In literature, Dr. Holme's marked preference for history, general

and topographical, has been already noticed. His knowledge of the great writers of antiquity was eminently exact and comprehensive, for one who had not made philological pursuits more than subsidiary studies. He was decidedly more conversant with the prose writers than with the poets of the ancient world. He does not appear to have cultivated the art of composition in either of the dead languages with peculiar care. His *Thesis*, at least, as respects its Latinity, does not surpass the ordinary level of such exercises in the foreign or northern schools of medicine, in elegance of style or purity of language. It appears from the Archives of the Literary and Philosophical Society, that between the years 1794 and 1838, Dr. Holme had communicated to that body fourteen essays, on various questions in literature and natural history.* One of these, the explanation of a Roman inscription, found in the Castle-field, Manchester, is published, in vol. v., p. 675, of the *Manchester Memoirs*. The others, though selected for publication by the Council, were all withdrawn by their author; only one of them, the essay "On the Progress of Sculpture to the time of Phidias, with Remarks on the Charges against him," has been discovered among his papers, and is now in course of publication in the forthcoming volume of the Memoirs of the Society. There has also been found in his repositories a considerable portion of a "Life of Sophocles." These performances and a single letter to Dr. Parr, published by Dr. Johnstone,† constitute our only materials for estimating his powers as a writer. It is evident, on a simple inspection of his manuscript of the "Life of Sophocles," that the process of composition was to him one of considerable labour. The manuscript is throughout deformed with numerous erasures and interlineations; the introductory sentences, especially, have more than once been entirely reconstructed, and there are constantly recurring examples of the careful poising and fastidious selection of language and of altered arrangement, before his taste and judgment were finally satisfied. This hesitation and undue fastidiousness in the choice of expressions are the more worthy of remark, that the "Essay on Sophocles" is devoted simply to research as to dates and facts, and does not touch upon matters of speculation or higher criticism, nor ever rises to the tone of impassioned writing. In the letters of his

* See Appendix.

† Parr's Works, vol. vii., p. 606.

various correspondents are to be found frequent complaints of his extreme and incorrigible delinquencies: even towards ladies he would seem to have been equally guilty of such sins of omission; for one, distinguished in natural science, thus writes to him,—"I urged that you never wrote to anybody; that you would travel miles, in order to convey a message to me by the pen of another, rather than write it to me yourself, and therefore I could assure her that you were incorrigible."

It appears that he was not more considerate towards Dr. Parr, who yet was in the habit of exacting punctilious deference from all his friends:—"I hope to convince you when we meet, that however flagrant my offences as a correspondent have been, they have not proceeded from a deficiency of veneration for your talents, of esteem for your virtues, or of gratitude for the numerous and kind attentions you have been pleased to show me." Finally, he concludes his "Essay on Phidias" with the following quotation:—"Nescio benevoli auditores, an vestram patientiam his nugis fatigaverim, *meam certe eas scribendo fatigavi.*"

The compositions, thus reluctantly and painfully elaborated, are perspicuous, terse, and even forcible. His style flows easily and not ungracefully, though it is rather colourless, and wants the sober and chastened ornament, which would seem not inappropriate to such a theme, as the grand conceptions of the Attic sculptor and dramatist. Indeed, the absence of all signs of emotion, in presence of the marbles of the Parthenon, and the noble choruses of the Œdipus Coloneus, (to which poem he had occasion to refer in assigning the Demos of Colonos as the birth-place of the poet,) and the preference of a cold and rigidly didactic treatment of topics so suggestive and kindling to the imagination, are strikingly characteristic of Dr. Holme's mental tendencies and inherent predilections. In his "Life of Sophocles" he has not soared beyond historical criticism on the value and significancy of the ancient authorities, by which the exact date and locality of the poet's birth, the social rank of his father, the names of his instructors in music and gymnastics, and his public appearance as a dancer round the trophies of Salamis, have been determined. His essay "On Sculpture" consists mainly of an assemblage of notices, gathered from various ancient writers, and chiefly from Pausanias, of the rude efforts of primeval art in Greece, and its

slow successive advances to the period of Phidias. He investigates, in conclusion, the charges of embezzlement which had been brought against the great sculptor, and which he successfully traces to political hostility. But neither of these essays furnishes anything like an adequate measure of Dr. Holme's intellectual power, or reflects any image of the impressive significancy of his spoken words, of the weight and authoritativeness of his actual presence and personal bearing. There is here no colossal footmark, whence we may infer the large proportions of him, by whom it was imprinted. In this absence of lasting written proofs of talent, and with little more to advance than traditions of his social prowess, inscribed, too, in the memories of a generation fast passing away, we can scarcely hope to satisfy those to whom he was not individually known, that he was so considerable a person as he was felt and acknowledged to be in Manchester.

With this closer insight into his habits of thought and study, we may now venture to reply to the inquiries that have been often urged—why Dr. Holme has written so little? and why he steadily refused to permit that little to be published? Nature is far from bestowing the faculties of speaking and writing in equal measure on the same individual;—the brilliant converser, the great orator, is not uniformly and necessarily great as a writer. Whether from parsimony of nature's gifts, or from want of early training in habits of composition, it is certain that Dr. Holme's thoughts did not readily embody themselves in language, and that it was only after repeated trials, that he succeeded in rendering written words in such measure the faithful equivalents of his thoughts, as to satisfy the vigilant severity of self-criticism. He wrote, therefore, always most reluctantly, and, doubtless, was conscious that what had been thus painfully elaborated was beneath, if not his actual powers, at least their high general appreciation. It was one of his few moral weaknesses, that he had too obvious a consciousness of his mental superiority, and that he attached an undue value to unrivalled social pre-eminence. He was probably averse to imperil his high intellectual rank, and preferred absolute suppression of his literary productions to the hazard of being judged like Galba,—"Omnium consensu capax imperii nisi imperasset."

It was, therefore, not by *written* compositions that Dr. Holme established a reputation unchallenged, wherever he was known, for great learning and uncommon intellectual power, but by *oral* outpourings of knowledge. In the circle of society, in Manchester, most remarkable for mental culture, he certainly occupied, by consent of all, the foremost rank as a most instructive and impressive converser. His presence, countenance, and personal bearing, were well fitted to inspire respect. He had a massive voluminous head, and especially that ample breadth of forehead, which is generally the sign of high intelligence. His voice, till enfeebled by advancing years, was masculine and flexible; his manner, always vigorous, became energetic and authoritative, when he was excited by argument. Men of superior powers listened with deference to the deliberate opinions that had been wrought out by his robust understanding; even Parr abated, in his presence, much of his domineering tone, and paid a cheerful homage to his talents and learning. The main source of his astonishing conversational success was obviously the inexhaustible affluence of his knowledge, gathered from the widest range of study, always producible at pleasure, and emphatically *exact* as to date, number, and every minutest accessory. Thus armed by nature, and by study, he was a formidable antagonist in discussion, and rarely failed to overbear all opposition by a resistless torrent of facts, citations, and recondite learning. The late Rev. George Walker was one of the few who ventured to contend with him in this intellectual gladiatorship, and we are told that the peaceful order of the social meetings of that period was often disturbed by the impetuous warmth of both disputants. In such discussions of more temperate character, the memories of which his friends now willingly recal, Dr. Holme's strength seemed to lie rather in the soundness, precision, and massiveness of his learning, and in the lucid clearness of its exposition, than in dialectic subtlety or stringency of reasoning; indeed, it sometimes appeared as if the prodigious strength of his memory contained in itself an element of weakness,—the too exuberant detail which crowded on his mind, averting its gaze from the main principle at issue, and thus impairing the closeness and logical cogency of argument. It may be safely affirmed that his mind was always more prone to dwell complacently on detailed knowledge, than to soar from thence to larger prospects and loftier generalizations.

It cannot fail to have been apparent, that in Dr. Holme's mental organization, memory was the strongest and dominant faculty. What he had once read or heard remained with him an inalienable possession, a "κτημα ες αει," as if engraven on tablets of brass or marble. Nor was his memory more remarkable for the tenaciousness of its grasp, than for the readiness of its responses, when invoked. Like the slave of the lamp, in the Arabian story, it was both the unerring guardian of all that was entrusted to its keeping, and prompt to bring up these hoarded treasures at its master's slightest signal. He had a quick apprehension of truth, and the command of large means for its illustration and enforcement. The reasoning faculty, though doubtless vigorous, was scarcely of strength commensurate with that of his memory; thus he was certainly not so happy in discussing questions, to be resolved by a long inductive process, as those which were merely dependent on a reference to facts, or a weighing of authorities. His taste in art and letters was rather severely discriminative and sternly correct, than readily impressible or keenly sensitive; indeed, he had no great warmth or mobility of imagination, and was therefore decidedly wanting in susceptibility to the emotions kindled by poetry, and by the higher philosophy.

Of his moral excellencies it is not easy, for one who has been honoured from childhood by his benevolent notice and steady friendship, to speak with measured reserve. His affections were deep, generous, and fervent, and gave birth to friendships, characterized no less by their warmth than by their unswerving constancy. He had survived nearly all the friends of his youth, but maintained a steady affectionate interest in their children, and in some instances, even in their remoter descendants. The wise and considerate munificence of many of his latest bequests touchingly recals to us his fidelity to the memories of the past, and the ever-thoughtful benevolence and genial kindliness of his nature.

Towards those under his medical care his manner was, in essentials, kind and encouraging. It was not his habit to give way to much expression of sympathy, and he at times betrayed some impatience and abruptness, when urged with questions which he did not deem it judicious or convenient to satisfy. But these signs of irritability were never more than momentary, and

could not cause serious pain to those who knew, that the same warmth of temperament was in him the parent of the most generous affections, and of the most actively beneficent virtues. It is scarcely needful to add that he was ever ready, when expedient, cheerfully and spontaneously to forego the emoluments of his profession, because this liberality of spirit may be safely predicated of the great body of its members.

His bearing in consultation, and indeed in all the intercourse of life, towards the younger members of his profession, was ever characterized by benevolent courtesy, kindly encouragement, and invaluable counsels. His library, his own time, and his vast stores of knowledge, were always accessible to them, and he manifestly experienced the purest and most intense gratification in thus influencing for good his younger friends, and in witnessing the affectionate reverence with which they regarded him. Having erected for his own governance a high standard of moral rectitude, he was severe in his requirement from them, of unsullied morals and scrupulously honourable bearing, and he is even known to have peremptorily declined meeting in consultation one who, he conceived, had transgressed these laws in the relations of private life.

In these, and in all other respects, he bore worthily the mantle transmitted to him by his great predecessors, Percival and Ferriar, and like them,—by his delicate sense of honour,—by his pure and lofty moral bearing,—by the singleness of purpose with which he dedicated his faculties, through a long life, to the best and noblest uses,—he maintained, in Manchester, the just rank and high station of medicine, as a liberal profession, as the worthy calling of an enlightened scholar, and of a high-minded gentleman.

APPENDIX.

ESSAYS READ BEFORE THE "LITERARY AND PHILOSOPHICAL SOCIETY."

1794, November 20.—"On the Origin of the Tribes which inhabit the Islands of the Pacific Ocean."

1795, April 17.—"An Inquiry into the Origin of the Ancient Inhabitants of Egypt."

1796, May 6.—"Observations on the Art of Etching on Glass."

1796, December 30.—"On the Demon of Socrates."

1797, December 15.—"On the Colour of Negroes, with Illustrations of the Law of Habit, and its Propagation by Descent in the Vegetable and Animal Kingdom."

1797, December 29.—Continuation of this Essay.

1798, November 2.—"On the Distribution and Physiology of the Nerves of the Heart."

1800, January 10.—"Conjectures relative to the Simile of Homer of the Cranes and Pigmies."

1801, January 9.—"An Entomological Fragment."

1802, February 24.—"Note on a Roman Inscription on a Stone found in Castlefield, Manchester, published in vol. v., p. 677, of the *Manchester Memoirs*.

1802, April 15.—"A Sketch of the History of the Greek Gymnastics."

1803, March 25.—"On the Existence of the Unicorn."

1816, November 16.—"The History of Sculpture from the earliest period to the time of Phidias."

1838, November 27.—"On a Runic Inscription discovered in Lancashire."

The Author of the foregoing Memoir is desirous of expressing his deep sense of obligation to his valued friends, Dr. Lyon and Dr. Hibbert Ware. Dr. Lyon, besides freely communicating his own remembrances of Dr. Holme, kindly performed the laborious office of examining a bulky mass of papers, and of selecting such documents as he deemed available for this biography. To Dr. Hibbert Ware the Author is indebted for a long series of unreserved letters, throwing invaluable light on Dr. Holme's earlier career or "initiative life." Copious extracts from these letters will be found embodied in the Memoir; but their general spirit has often influenced the writer where no specific reference was admissible.

W. C. H.

Haffield, near Ledbury,
June 24th, 1848.

AN ESSAY

ON

THE CEREBRAL AFFECTIONS

OCCURRING MOST COMMONLY

IN INFANCY AND CHILDHOOD;

INCLUDING NOTICES OF

THEIR HISTORY, CAUSES, DIAGNOSIS, PROGNOSIS, AND TREATMENT.

BY VALENTINE DUKE, M.D.,

Being the Council Prize Essay, awarded at the Annual Meeting

OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION,

HELD AT BATH,

On Wednesday and Thursday, August 16th & 17th, 1848.

Few diseases which engage the attention of the physician, are more interesting in their nature, or important in their results, than the cerebral affections of infancy and childhood; whether we regard the tender age and helpless condition of the sufferer, the extreme anxiety which is felt by parents, when those so dear are afflicted, by what must ever be considered dangerous maladies, or the mighty interests that are at stake,—the inestimable blessing of sound reason and its enjoyment so frequently depending upon the issue.

In another point of view also, they are a class of diseases claiming the closest attention of the physician; both from the frequency of their occurrence, and in so far as his own reputation is concerned. Diagnosis, in these cases, is frequently very difficult, and is often still further obscured by the impossibility of obtaining any information to assist us from the little patients themselves. Hence the necessity for great tact and practical familiarity with all the phases under which the attack may be made, to facilitate

the recognition of their nature, at an early period, when alone our art may be made available effectually to combat them. Some of these affections are so very acute in their progress, and disorganization of the delicate structures engaged, takes place so rapidly, that unless the way is clearly seen, and the course of treatment promptly adopted and vigorously carried out, our very best efforts are unavailing. Hesitation and uncertainty may occasion the loss of a patient—mistakes made may be fatal, and especially in the cases of children, are never forgotten.

Notwithstanding all that has been written upon the subject, and the clear manner in which the differential diagnosis has been attempted to be established, the practical physician will admit the great difficulty he sometimes experiences in pronouncing upon the nature of the case. We are frequently not called in, until the time has passed when the early observation of symptoms might have afforded greater facilities for drawing inferences. Unfortunately it happens, often too, that cerebral affections are so insidious in their approach, so masked by some prominent, remote, sympathetic affection, or so little characterized by any very decided pathognomonic symptoms, that they are overlooked by the friends in the early stages, and the doctor is called in, only to be able to confirm the apprehension that has been accidentally excited, for the safety of the head. The child may have been astray for some time, and have lost flesh,—but it was only teething, and has often been so before. True it has had vomiting, but then the food disagreed; or if it be an infant suckling, the mother has been anxious, and has lost her rest—enough to cause that. There is a ready and familiar way to account for every symptom, but the lurking disease is overlooked, or not suspected. The supervention of convulsions, screaming, severe head-ache, or perhaps sudden coma, arouses anxiety, and directs attention to the head, and then too often, irremediable mischief has been done.

Medical literature has furnished many treatises upon the affections of the head in infancy. Some are voluminous, embracing every disease; some are valuable monographs; many are inaccessible to the ordinary student from their scarcity, and some from being published in a language with which he is not acquainted. My endeavour, in the following pages, will not be to furnish a perfect encyclopædic history of those diseases, but rather a concise account

of those occurring most frequently, with extracts from the most valuable works to which I have had access, introducing such practical observations, especially upon diagnosis and treatment, as a considerable experience in, and familiarity with, the diseases of children, enable me to offer. As the practical utility of the treatise is chiefly aimed at, I shall excuse myself for not following strictly any particular author's classification, but shall adopt in each instance, that which seems most likely to convey the clearest views of the particular disease under consideration, being truest to nature, and appearing best marked, by some strong, easily recognized, and generally occurring characteristic.

From the very early medical history of cerebral affections in infancy and childhood, we do not gather much information that is valuable. There existed, even until the middle of the last century, great obscurity as to the diagnosis, complete ignorance of the pathology, and doubt and despondence about the treatment. Until the work of Dr. Whytt was published in Edinburgh, the matter does not seem to have received really scientific attention, but his views of the subject, possessing considerable novelty, aroused other authors, and we find Drs. Fothergill, Watson, Dobson, &c., soon in the field of publication. Afterwards, and at about the same period, 1791, Drs. Rush, of Philadelphia, and Quin, of Dublin, devoted attention to this subject, and by propounding new and more correct views of the nature of hydrocephalus, added much to the knowledge that was possessed. These authors were followed by the late Dr. Cheyne, of Dublin, who treated of the same disease, in two very able essays, which still form a text-book, and retain a deservedly high character.

Among our continental brethren, too, much has been done. Gölis's treatise, so well known, is very complete and valuable, and from the works of MM. Rilliet, Guersent, &c., we derive much useful information, pathological as well as practical.

To modern English authors also, this department of practical medicine is very much indebted, and from the lectures of Drs. West and Willshire, and the publications of Dr. Marshall Hall, I have derived much information. To several others also, from whom I have received hints, or from whom I may have quoted passages, I beg to make my acknowledgments.

Clearness of style, distinctness of expression, and a facility of conveying to the reader the author's views upon a subject, are amongst the recommendations in such an essay as this; and being so convinced, I have aimed at rendering this treatise useful, and easily understood and remembered, rather than very apparently learned or laboured, by numerous quotations, or the use of a greater number of new or technical terms, than is necessary for the proper description of each disease.

CONGESTION OF THE BRAIN.

We shall commence the account of cerebral affections in infancy by noticing the occurrence of congestion of the brain, which sometimes is present at, or occurs immediately after, birth. This is rather a rare occurrence, and we more frequently meet with the affection at a later period of life. It arises from several causes,—as a neglected state of the bowels, exposure to cold, an impediment to the return of blood from the head, &c. I have known it to occur and prove fatal in twenty-four hours, from sudden passion in a nurse; and there are strong grounds for believing that the free use of spirituous and fermented liquors, by suckling mothers, has frequently induced it. It is liable to occur also during the course of the exanthemata and hooping-cough; the latter, in my experience, having been a most fruitful source of it.

"When suffering from congestion, the child will be stupid and heavy, the head looking full, and being perhaps hotter than usual, the veins distended and dark coloured, the countenance livid, and the pulse slow, or irregular; the pupils are usually dilated, and the eyes looking vacant; a permanently elevated and convex condition of the fontanelles, leaves no doubt of its existence." (Maunsell and Evanson.) If unrelieved, these symptoms may be followed by effusion, and death take place in twenty-four hours.

The treatment must consist in removing the cause, if we have control over it, and next in relieving symptoms. Cold applications to the head, with perhaps the general warm bath, and freely acting on the bowels, will generally be sufficient; but if the lividity of countenance, or the nature of the breathing, denote danger, we must apply leeches. Blisters will also be found useful, and both these remedies are recommended to be applied to the extremities,

rather than the head. I should select the nape of the neck as the part best suited for blistering. Tonics and stimulants may be necessary to prevent a recurrence of the symptoms of congestion.

IRRITATION, OR ERETHISM OF THE BRAIN.

Morbid irritation, or erethism of the brain, is also sometimes met with amongst infants, especially in large cities. It is characterized by an increased irritability of the sensorium, and susceptibility to impressions; noise and light are equally disagreeable, and the child is uneasy and fretful. The eyelids are generally closed, and the flexion of the thumb on the palm of the hand, so well-known to nurses, is constantly observed. The child is generally very watchful, and gets little sleep. There is not any complaint of pain in the head, nor is there increased frequency of pulse, or heat of skin.

This affection is generally attendant upon dentition, in delicate children, and may arise in them from every debilitating cause. I have seen it occur after remittent fever, long protracted; and also after diarrhœa. If this state of morbid irritation should exist long, hydrocephalus might be induced. Congestion of the brain, which we have already spoken of, and the hydrencephaloid disease, to be hereafter described, have many symptoms in common with erethism. The watchfulness and extreme sensibility in this case will contrast with the stupor and tendency to coma in the former. Our principal efforts must be directed to allay irritability and procure sleep; we must also be careful to support the strength, by light nourishment, but stimulants, as wine, must be avoided. The bowels must be evacuated by enemata and mild aperients; cold also should be assiduously applied to the head, and warm stupes to the feet; a very nice method of applying the latter is by means of flannel wrung out of hot water, rolled round the legs and feet, this again being wrapped up in a warm, dry piece of flannel, or small blanket. I have frequently known this procure sleep, in many of the affections of childhood, and it has the recommendation of disturbing the child very little, and is applicable in cases where the fatigue of a general warm bath would be too great. Nothing will sooner relieve our patient and assist the means we prescribe than change of air. It really acts

sometimes magically, as all who have seen much of the diseases of children can vouch. Sometimes it may be necessary to have recourse to the use of opium, which, if cautiously and prudently administered, will prove a useful assistant in breaking the habit of wakefulness and procuring sleep.

THE HYDRENCEPHALOID DISEASE.

The hydrencephaloid disease was first particularly described by Dr. Marshall Hall. "This affection," he says, in his admirable essay on the subject, "may be divided into two stages; the first that of irritability, the second that of torpor. In the former, there appears to be a feeble attempt at reaction; in the latter, the powers appear to be more prostrate. These two stages resemble, in many of their symptoms, the first and second stages of hydrocephalus respectively."

It is very necessary to be thoroughly acquainted with the circumstances under which this disease is likely to occur; for the symptoms are not peculiar to it, but may occur in other affections requiring a very different treatment; to wit, in hydrocephalus and in morbid irritability of the brain. If we trace the history of the case, we shall generally find that there has been some considerable evacuation, either loss of blood in the cure of some other affection, or long existing diarrhœa. The infant at first is irritable and peevish; he starts upon being touched, and is over-sensitive. There is sighing and moaning during sleep, and sometimes screaming. Here are symptoms, some of which are present in the erethism of the brain, and some in hydrocephalus; and it will require the closest attention to the history of the case, to enable us to discriminate between them. As the disease advances, the exhaustion is more apparent; the countenance becomes pale, and the cheeks cool; the eyelids are half closed, the eyes fixed, and unattracted by any object placed before them; the pupils unmoved by light; vomiting is sometimes present, and the bowels are rather free than constipated, though the evacuations are unhealthy. You must meet these symptoms by supporting the system, administering gentle stimulants, and such moderate doses of opium as may allay irritability, or check diarrhœa, if present. Dover's powder is a very manageable form in which to use this

medicine, and the starch enema, with opium, will be generally effectual when diarrhœa exists. If vomiting be present, we must try to allay it by administering small quantities of nourishment, as chicken-broth; or if the exhaustion be very great, by stimulants, as wine, or even brandy. A small blister for an hour, over the stomach, will often materially assist in checking vomiting. If there be great coldness of the surface, we may use the warm bath for a short time; and the water may be made stimulating, by the addition of some mustard. After the symptoms have been subdued, tonics must be administered to prevent relapse, and, as before mentioned, change of air is most desirable. Should we, by oversight or mistake of its real character, treat this case by continued depletion, our patient would assuredly sink rapidly, and die comatose, or convulsed.

The application of cold to the head, so useful in most of the cerebral affections of infancy, would here be badly borne.

Should the symptoms not be relieved, the child may die seemingly exhausted, and examination would very likely show considerable serous effusion in the ventricles; but then this would have been more of a passive nature, than the result of acute inflammation.

Symptoms of exhaustion are frequently seen in children who are imperfectly nourished, either on account of deficient supply, or the bad quality of the nurse's milk. These matters must be closely inquired into by the physician, and his treatment regulated accordingly. The change of a nurse, under such circumstances, is imperatively called for.

Great attention should also be paid to the nourishment a child receives after being weaned, especially if that process has been suddenly carried into effect, from any necessary cause. The assimilating powers of the digestive apparatus, are weak, and disease of the brain may result from deficient nutriment.

CONVULSIONS.

Disturbance of the nervous system in children, whether functional or organic, more constantly declares itself by the occurrence of involuntary muscular movements, than by the complete loss of motor power in any part.

Every one is aware of the frequency which convulsions are met with, in early life, and the apparently trifling causes from which they seem often to arise. Delicate children are more liable to them than those who are more robust, while the danger to be apprehended is greater in the latter. Perfect paralysis of a limb will also occasionally occur in a child, and, though always a source of considerable anxiety, and occasionally incurable, is not so indicative of deep-seated disease as when we meet with it in an adult.

If paralysis in a child resists treatment, and remains permanent, we may reasonably conclude that it depends upon some organic affection.

Convulsions are so very well known, both to the medical man and to all mothers, that a minute description of them here would be superfluous.

Every portion of the muscular system, voluntary and involuntary, may partake of the morbid action. The attack may be very severe, of long continuance, and often repeated; or there may be but slight spasmodic twitchings in a few muscles, as those of the face and hands. The danger to be apprehended, arises more from their persistence and repetition, than from the apparent severity of the attack.

The causes of convulsions are very various; every affection of the brain and nervous system seems liable to be accompanied by them. It is mentioned, indeed, by Dr. West, "that convulsions in infancy and childhood seem to take the place of delirium in adult life." We meet with them in every lesion of the brain, functional or organic, and proceeding from very opposite states of that organ. In congestion, morbid irritation, and the later stage of the hydrencephaloid disease, as well as in acute and tubercular meningitis. All inflammatory affections in children are liable to cause, or be attended by, convulsions. Pneumonia more particularly, is often thus ushered in, and spasm of the glottis is constantly accompanied by them. The natural process of teething is a frequent exciting cause, and more remote sympathetic irritation also gives rise to them, as that caused by worms, flatulence, and indigestion. Mental impressions, as excessive fright, will also occasion convulsions.

The treatment must depend mainly upon the removal of the cause of the attack. The discovery of this is very often a difficult

matter, but we shall generally proceed safely, in ordering cooling applications to the head, having the bowels well freed, and directing the use of the tepid or warm bath; sprinkling cold water in the face is a means also recommended; I have seen it shorten and prevent the seizure. When some distinctive symptoms are present, localizing the cause, we can apply ourselves more particularly to their removal. Carminatives, with turpentine and assafœtida enemata, will procure the discharge of flatus, generally followed by great relief.

Lancing the gums should never be neglected; it will often induce sound sleep, and hinder a return of the attack. Sometimes, especially where there is a tendency to somnolence or coma after the seizure, the application of a couple of leeches will considerably lessen the liability to a recurrence. In such a case, we must be very cautious in the use of cold to the head. We must not attempt to shorten the attacks, by the administration of opium, or too frequent use of antispasmodics; but aim rather at removal of the cause. In cases of morbid irritation, and sometimes also in the hydrencephaloid disease, we do use opium and stimulants with advantage. The termination must always depend upon the cause, and on success in its removal. The danger of a fatal termination is not greatest in the most delicate children. The long continuance of convulsions may give rise to very serious injury of the sensorium. When they resist treatment, and recur constantly, always order change of air, and very likely in such cases, tonics may be necessary.

ACUTE MENINGITIS.

Amongst the most rapidly fatal of the diseases of the brain in children, is acute inflammation of that organ and its membranes. Fortunately, it is a disease of comparative rarity in this country, and some authors still describe it as only a variety of hydrocephalus. There are very abundant reasons, however, for considering it as a distinct affection, as its causes, course, and termination fully testify.

Unlike the tubercular meningitis, to be described hereafter, this affection usually attacks strong and previously healthy children, and in a very sudden manner. It is generally so acute, and accompanied by such severe symptoms, that it is not long overlooked, but very soon comes under medical care; but unfortunately,

though early recognized, it is not as amenable to treatment as acute inflammations elsewhere, or even as the same disease is in advanced life. This may be accounted for in part, by considering the very rapid growth of the brain in infancy, and the abundant manner in which it is supplied with blood.

The causes which most frequently give rise to this affection are, exposure for a lengthened period to the sun's rays; injuries received, as direct blows, and wounds penetrating the orbit and other parts of the cranium; dentition at both periods. It is sometimes epidemic, and occasionally occurs without any assignable cause. It accompanies or follows other diseases, as the exanthemata, and has, in some cases which came under my own observation, been connected with sudden suppression of purulent discharge from the ear. It is sometimes caused by the repercussion of cutaneous affections of the scalp. Often, however, the closest attention cannot discover any cause sufficient to account for the attack.

The infant daughter of an esteemed medical friend, has recently been the subject of a very severe attack of acute meningitis, the accession of which was sudden, and could not be traced to any cause, and, but for the very active treatment promptly adopted, it would most likely have proved fatal within twenty-four hours. In this case also, there seemed to have been an extension of the inflammation to the spinal cord; for there was considerable rigidity of the lower limbs, and inability to use them for a long time, after all other symptoms had disappeared. I have more than once seen the cerebral symptoms which occasionally precede an attack of small-pox, give rise to decided meningitis.

Attacks of otitis are by no means rare, or of uncommon occurrence in infants. The symptoms closely simulate those of meningitis, and may, no doubt, if unrelieved, lead to the graver disorder.

Phlebitis of the sinuses of the dura mater, a disease very rarely met with, may give rise to general inflammation of the brain and membranes.

Symptoms of Acute Meningitis.—Authors divide this disease into the phrenitic and convulsive forms, according as the intellectual faculties may be primarily and particularly engaged, or as convulsions may occur early in, or characterize the attack. In the

phrenitic form, however, convulsions are not wholly absent, neither does the intellect escape entirely in the convulsive. The former, as might be expected, occurs more frequently in children of four years old and upwards, who have begun to exercise actively their reasoning powers; the latter in younger infants. The convulsive form usually commences suddenly, by an attack of convulsions, general or partial. There is febrile disturbance, but not so great as in the phrenitic variety; vomiting and constipation are not so usually observed. The convulsions are repeated at short intervals, and between times the child remains either very much agitated or comatose, with the pupils mostly contracted, and very likely there is squinting; sometimes we have hemiplegia.

In the phrenitic form there is generally a rigor, followed by fever and vomiting, with head-ache, intolerance of light and noise, quick pulse, hot and burning skin; the child is very restless and answers questions abruptly and peevishly. The intellect becomes soon engaged, and, as the disease advances, the symptoms indicative of derangement of the nervous system become more marked; the head-ache is intense, with frowning; delirium, of a violent character, is present, alternating with stupor. Convulsions now occur, and there is strabismus, with contracted pupil. The child lies with his eyes closed, and face averted from the light; he often starts and screams with the violent pain, which is so severe as quite to deprive him of sleep. The respiration and circulation are also much affected; the former is hurried and irregular, presenting that character so well known in fever, as cerebral breathing. The pulse is very quick, and generally strong and full, but variable. The face is alternately flushed and pale, with an aspect wild, at times; at others, expressive of great suffering. The skin is burning hot and dry. The digestive system also sympathizes. The tongue is red and dry; vomiting of bilious matter incessant, and the thirst urgent. The excretions from the bowels are scanty, and the urine high-coloured and diminished in quantity. If the disease be not arrested by treatment, the convulsions become more frequent and severe, with grinding of the teeth, strabismus, dilated pupil and coma; where it is protracted, hemiplegia is sometimes present, and occasionally spasms of the muscles of the arms and legs; these latter more particularly when there has been an extension to the spine of the diseased action.

Diagnosis.—When we come to make the diagnosis of this disease, we must recollect that many of the most prominent symptoms indicate other affections of the cerebrum as well, and, accordingly, we must be guarded in pronouncing upon the nature of the case, and carefully draw our inferences from the history of the attack, and a consideration of the entire of the symptoms. The child is often very young, and can only make us acquainted with its feelings and sufferings by gestures. The age and appearance of the patient, the probable cause, the mode of attack, and the intensity of symptoms, must be closely inquired about; the former, because we know that this affection is most frequently met with during the periods of dentition, primary and secondary, and because it most constantly attacks strong, healthy children, who have not shown any scrofulous symptoms, nor had previous debilitating illness; the latter, because the history of the case, its rapid seizure, acute symptoms, and speedy progress, will assist in enabling us to distinguish it from the more slow and insidious attack of tubercular meningitis or common hydrocephalus. This latter may, no doubt, be ushered in by acute symptoms sometimes, but is generally slower in its progress; gives more notice of impending mischief; occurs, generally, in delicate, scrofulous children, who have shown previous symptoms of disease or have been often ailing; is characterized by particular states of the nervous and circulating systems, according with the period of its duration; is attended with more obstinate constipation, a different kind of pain of the head, and a lower degree of general fever, occasionally exhibiting irregular remissions. Closely observing and contrasting these symptoms, we shall seldom fail in making a correct diagnosis, which is most important in a practical point of view.

Acute meningitis can scarcely be confounded with congestion of the brain, unless in an advanced stage, when stupor or coma may have set in. In congestion, we shall not have had the acute pain, quick pulse, burning skin, &c., nor will there be the frowning, grinding of the teeth, nor severity of suffering, generally indicative of acute meningitis. In fact, close observation of the case will seldom permit a mistake in this matter.

Pneumonia in children is often ushered in by vomiting and convulsions, and may be mistaken for head-affection, of an acute

character. Again, we have symptoms of hydrocephalus occurring in the last stages of pneumonia, from hyperæmia of the brain. Careful attention to the state of the breathing, and examination of the physical signs by auscultation, will generally prevent us falling into error in the early attack, and we shall have had the symptoms and progress of the case to guard us in the later.

To distinguish between acute meningitis and the symptomatic convulsions arising from teething, worms, &c., we shall observe in these latter, that the convulsive seizures are less frequent; there is an interval of comparative quiet between them, in which the pulse and respiration are but little accelerated, and there is an absence of frowning, indicative of pain in the head. In acute meningitis there is no marked remission; often, no doubt, the symptoms are deceptive, and the closest observation will be at fault until the progress of the case reveals its real nature.

Hæmorrhage into the arachnoid membrane is a very rare disease in children; it does, however, occur, and has been distinctly described by authors. Convulsions appear amongst the earliest symptoms, but are in general less violent than those observed in meningitis. There is less fever and vascular excitement. Coma occurs sooner and gradually. M. Legendre states, that "children attacked with meningeal apoplexy, exhibit contractions of the fingers and toes, a symptom not observed in meningitis." I cannot verify this observation by experience, having never had an opportunity of making or witnessing an examination of a child who had died of apoplexy, and in whom this symptom had been noticed. I am pretty confident, however, that carpopedal flexions do occur in cases of acute meningitis, and in convulsions from other causes.

Inflammation of the brain, running a very rapid course, and proving quickly fatal, may be induced by the extension of disease from the ear; when a purulent discharge has existed for a long time from the meatus externus, its sudden suppression may be soon followed by indications of mischief, and these should always be promptly attended to.

In Dr. Abercrombie's work on "Diseases of the Brain," an account is given of a boy, aged fourteen years, who had been affected for two months with head-ache and discharges of matter from the right ear. A week before his death the pain increased, and was accompanied by great debility, giddiness, and some

vomiting. He continued in this state, without stupor or any other remarkable symptom, until the day of his death, when he was suddenly seized with convulsions, and died. An abscess was found in the middle lobe of the right hemisphere of the brain, and another in the cerebellum, and there was extensive caries of the pars petrosa, with effusion of three ounces of fluid in the ventricles. The symptoms during life would hardly have led us to expect such extensive disease.

Attacks of otitis are always accompanied by very severe suffering, and it is sometimes exceedingly difficult to say whether we have general inflammation or this local disease to deal with. It may be borne in mind that the latter is much the more frequent affection, in this country. Many children have otitis, more or less severe; few have meningitis. We may gather much from the child's manner, and the position it assumes. In otitis there is not the general wild, phrenzied manner, but rather an expression of severe local suffering. "The child lies on the affected side, and presses it against the pillow, or keeps its hand to the ear." If it can speak, it generally complains of the ear. Sometimes this part is red and swollen, and pressure and examination increase the suffering. Occasionally there is vomiting; but more usually it is absent. After a few hours of great pain, the child generally falls asleep, and awakes free from all symptoms, except perhaps a discharge of matter, which very often takes place. I have observed in some cases of inflammation of the brain, following upon a long continued discharge and probable extension of disease from the inner ear to the brain itself, that the symptoms were not as acute, nor the suffering so severe, as when the otitis came on suddenly, without previous disease; but it need scarcely be added that the danger is much greater in the former condition. I have seen several cases fatal from this cause.*

Prognosis.—Whether acute meningitis will terminate in death or recovery, depends, in a great degree, upon the cause from which it has arisen, and the period at which it has come under treatment. When arising from direct injury, as penetrating wounds, the prognosis must generally be unfavourable. Several

* *Vide*, Two excellent papers, by Mr. Wilde, "On Affections of the Membrana Tympani," in the *Dublin Quarterly Journal of Medical Science*, New Series, Nos. 8 and 9.

such cases are on record, as wounds of the orbit.* When occurring without any known cause, and met early by prompt and active treatment, it may generally be combated successfully. An impression, indeed, exists, that it is fully as fatal as the slower tubercular form of inflammation,—hydrocephalus. My field of observation has not furnished a sufficient number of cases of this disease, to warrant me in giving an opinion from actual contrast.

Examination after death reveals lesions, differing according to the age of the patient, and the duration of the disease. In cases which prove fatal early, we find pus, fluid, or semi-fluid, or concrete resembling false membrane, in the arachnoid and pia mater, the latter being deeply injected. When death has occurred later, we find false membranes, and the surface of the convolutions sometimes soft and very vascular. The morbid appearances are usually found upon the convexity of the brain, or in the ventricles, which are inflamed and infiltrated with purulent serum. In the tubercular variety of inflammation, the morbid appearances are most generally found at the base of the brain; and so uniformly is this the case, that M. Rilliet establishes a diagnosis between the two diseases founded upon this fact.

The cerebral substance may be slightly hardened, or but very little altered in appearance, if death has supervened early; but if not until after the fifth day or so, it may present an injected appearance, showing numerous bloody dots. In very young infants, the brain is sometimes softened throughout; the ventricles are generally found empty, or containing only a small quantity of sero-purulent fluid; but sometimes we meet with a large quantity of serum in them.

Treatment.—The treatment to be adopted must depend very much upon the stage of the disease in which it has been seen and recognized by the practitioner, and also upon the age of the patient, and in some degree upon the particular form of the meningitis present. As already mentioned, this disease runs a very rapid course, and occurs mostly in strong, healthy children, in whom we might expect to be called upon to use decidedly antiphlogistic measures.

* *Vide*, A paper by Dr. Geoghegan, on a very interesting "Case of Penetrating Wound of the Orbit," in the *Dublin Medical Press*, No. 177, May 25, 1842.

If we see the case early, we must bleed locally by leeches, and if the child numbers four or five years, from the arm or jugular vein as well. The quantity of blood to be abstracted must be determined by the age and strength of the child, and the impression made upon the disease by the evacuation. If the form we have to treat be the convulsive, bleeding must be practised; but we must early have recourse to the exhibition of purgatives, together with fœtid and turpentine enemata. These, with lancing of the gums and the application of cold to the head, should be our earliest remedies. Lancing the gums, though not seemingly necessary, because the teeth cannot be felt, should never be omitted. The enemata will take effect much more quickly than purgatives can, and by extricating hardened fæces and flatus, will afford much relief. When symptoms persist, after the use of such means, tartar-emetic will be found a most valuable remedy, though some difference of opinion exists as to the propriety of using it. When we consider the power it exercises in assisting to subdue other severe inflammatory affections, there does not appear any sufficient reason to prevent its application in this. Nausea, kept up for some hours, will often give a most beneficial check to the rapid progress of symptoms.

The warm bath is another remedy I would recommend the early trial of; indeed it is so very popular, that we shall be generally anticipated in this respect. It allays general irritation, equalizes the circulation, and tranquillizes the patient. Cold applications to the head should always accompany and follow its use.

Hours are of as much importance in this affection as days in some others; indeed the changes of a single hour, for better or worse, are sometimes very marked. If symptoms continue unrelieved, we must persevere with our remedies. Purgatives are to be repeated, and the loss of blood may again be called for. Some authors recommend applying leeches to the knee, or some distant part, as a derivative. Fomentations to the lower extremities and sinapisms will also be of use with this view.

Much reliance must be placed upon the speedy introduction of mercury. We cannot expect to salivate very young infants, but the system may be influenced, notwithstanding. Mercurial frictions are to be used; they assist in accomplishing this object, and spare the stomach. If we have used blisters, the surfaces

may be dressed with mercurial ointment, with the same effect in view.

I would recommend the early shaving of the head, and application of counter-irritants to the scalp, more especially when we have reason to suspect that the retrocession of a cutaneous affection may have had any share in inducing the disease. Tartar-emetic ointment, with croton oil, will generally be sufficient for this purpose. Before having recourse to this latter means, in cases where we do not suppose that the disappearance of an eruption has had anything to do in producing the meningitis, the application of cold should be long and perseveringly tried. A thin towel, frequently wetted and kept upon the head, seems as good a method of using this as we can select. Ice, in bladders, is also recommended; and a method of slow irrigation, by means of a thread, conducting cold water from a vessel placed over the child's head, is recommended by M. Rilliet. I have had the child's head held over the side of the bed, and cold water poured in a stream from the spout of a tea-kettle, for several minutes, with decided benefit.

In our attempt to introduce mercury into the system, we need not fear to combine it with small quantities of opium. The tendency to coma is not so great as to be increased by the latter, to any alarming extent. Small doses of Dover's powder will be found very useful in allaying irritation and procuring sleep.

Such active treatment as this recommended, will frequently succeed in arresting the disease; but unfortunately we are often disappointed, and it runs its rapidly fatal course, unchecked, in from twenty-four hours to three days. I have never known any benefit derived from the exhibition of medicines with the view of checking the vomiting. The child generally asks for cold water, when able to speak, and this he should have freely. I should mention that we must be careful not to persevere in the use of cold to the head too long, if we have reason to apprehend the supervention of coma. Blisters applied to the nape of the neck will lessen this tendency, and some recommend them to the inside of the thighs and legs also. The blister on the neck may be kept open with advantage for some time, even after all severe symptoms have disappeared. It will be necessary to carefully guard against noise and light, and also to avoid every needless excitement.

HYDROCEPHALUS ACUTUS.—TUBERCULAR MENINGITIS.

Amongst the affections of the head to which infancy and childhood are liable, none occupies a more prominent position than hydrocephalus. It is the disease of every stage of early life, and happens at all seasons. Perhaps we are not justified in so closely connecting its occurrence with the periods of dentition, as that of the disease already treated of under the name of acute meningitis; neither should we be quite correct in saying that those epochs do not exercise an influence over it. Certain it is, that we encounter it at all times, and under all circumstances; but, as will hereafter be shown, it is so very often preceded by, and seemingly dependent upon, derangements of the digestive apparatus, and these so constantly accompany the periods of dentition, that we may safely say there is a very great liability to its occurrence at those times.

Modern practice of medicine may fairly boast of the improvements effected in this particular branch. In the early notices which we have of this affection, its real nature seems to have been very imperfectly understood. It was, indeed, recognized as a peculiar disease, but there was a lamentable want of information as to its pathology and treatment. The effect was looked upon as the cause, and the name was not applied until symptoms showed themselves, which were thought to depend upon the effusion of fluid. We now know that there are not any symptoms which clearly and unequivocally point out the occurrence of effusion into the ventricles,—those cases which have proved fatal, exhibiting the worst symptoms, severe convulsions, strabismus, coma, &c., often, upon dissection, furnishing the least quantity of watery effusion, and *vice versa*. In fact, we are fully warranted in asserting that, until the later periods of the preceding century, there existed great obscurity in the diagnosis, very erroneous views of the causes and pathology, and necessarily a very unsuccessful method of treating this disease.

The authors who wrote about it, described the symptoms with considerable accuracy, each succeeding one adding something to the general amount of information; but all seem to have had their attention arrested by the consequence, rather than the cause, and to have been at greater pains to account, by hypothesis, for

the occurrence of the serous effusion, which generally took place in the later stages, than to trace the origin of the disease itself, or apply themselves vigorously to its successful treatment. Indeed at this time it was generally pronounced incurable; and so very hopeless did they consider the cases, and so little reliance was placed upon treatment, that one physician of eminence writes thus:—"I do not suggest any probable means of curing the disease, which has baffled my skill, both when alone, and when in consultation with the ablest of the faculty; and as I do not deem the cure of it within the compass of art, the ostensible reason for publishing this paper is, to exhibit such an idea of hydrocephalus as may serve to make its fatal tendency known to the practitioner, so as to justify him to himself, and to those who might deplore his ill success."

Occasionally, however, a very unpromising case terminated favourably; and, by degrees, the light of science dawned upon this dark and intricate path. Perhaps Dr. Whytt was the earliest systematic writer upon hydrocephalus whose work effected an improvement. He described the symptoms most accurately, and was the first to adopt the division into stages, which all succeeding authors have followed. Some twenty years afterwards, and at about the same period, Drs. Rush, of Philadelphia, and Quin, of Dublin, conceived new views of the nature of hydrocephalus, and shortly after published their opinions,—that it was in reality a disease of an inflammatory nature, and that the watery effusion was a termination of this inflammation, and not a cause of the disease, as hitherto supposed. Dr. Quin supported his views by dissections of some cases which had proved fatal, showing that "there were remains of greatly increased vascular action in the brain, and yet no effusion of fluid had taken place, although there had been unequivocal symptoms of hydrocephalus present;" and in other dissections he also proved, that "while the quantity of serum effused was considerable, the blood-vessels were remarkably turgid, and what was still more decisive of inflammatory action, preternatural adhesions connected the meninges, which were thickened, opaque, and coated with coagulable lymph." Dr. Rush also published cases supporting his views as to the inflammatory nature of the disease, and adding considerably to the pathological knowledge of it. Still his ideas, as to its intimate

nature, do not accord with the opinions of modern physicians; he considered it as almost identical with phrenitis, differing in degree only, and hence he named it "Phrenicula." With more correct views of the nature and pathology, came improvements also in the treatment, and this hopeless and incurable disease became more manageable. Mercury, which had been recommended by Dr. Dobson, in 1775, cold applications to the head, and blisters were used; physicians laid aside despondency, and applied themselves with energy to the study of the malady.

To the late Dr. Cheyne, of Dublin, we are particularly indebted for an able essay upon this subject, published in 1808, and followed by a second in 1819. These papers effected more towards classifying symptoms, facilitating diagnosis, and improving practice, than any of their predecessors. Dr. Cheyne dwelt particularly upon the frequent connection between disease of the alimentary canal, and the occurrence of symptoms of head-affection, and pointed out with accuracy the early symptoms which characterized hydrocephalus; he also forcibly inculcated the necessity of using prompt measures, in order to secure success in our treatment.

The disease had been, before Cheyne's time, divided by Dr. Whytt into three stages, that division being founded chiefly upon the variability observed in the state of the pulse, at different times, during the progress of the disorder. Cheyne also recognizes three stages, but founds the division upon a more constant and unerring occurrence, namely, the state of the sensorium at those particular periods. To the stages of quickened pulse, slow pulse and again quickened pulse of Whytt, correspond the stage of increased sensibility, the stage of diminished sensibility, and the stage distinguished by palsy and convulsions of Cheyne; but, as he observes, "The student will be disappointed if he expects that these stages will always follow each other in a regular and measured progress." Very great variability is observed in cases, both as to their duration, and the distinctness with which the different periods, or stages, can be recognized. We may remark that these will be most distinct in those cases which are slow in their progress.

Many other English authors have laboured in this field, and have added much to our information, both as to the nature and treatment of hydrocephalus. The principal improvements consist

in having facilitated the diagnosis, and confirmed the necessity for antiphlogistic treatment, and such as will improve the state of the biliary and other digestive organs. We are much indebted to our continental brethren also, for their additions to the literature of this subject. To their minute pathological investigations, we principally owe our knowledge of the fact, that hydrocephalus has almost always a tubercular origin, and that it is frequently complicated with tubercular deposit, elsewhere than in the brain. Gölis's treatise is deservedly looked upon as most complete, and MM. Guersent, Rilliet, and Barthez have contributed much useful information. To their works, and also to the able lectures of Doctors West and Willshire, I beg to acknowledge my obligations for many useful hints.

Having brought the history of this disease down to modern times, we shall proceed to consider it in the manner already set forth, passsing in review its causes, symptoms, diagnosis, prognosis, and treatment.

After a careful perusal of various works, it appears to me that the account of the origin and progress of this disease, given by Dr. Cheyne, is by far the clearest, most concise, and withal most true to nature of any I have met with. Any attempt upon my part to improve it would be so futile, that I shall take the liberty of quoting from his work such portions as more particularly bear upon the object we have in view.

From great experience and close observation of the disease, Dr. Cheyne was led to believe that hydrocephalus very often depended upon, or was the consequence of, a disordered condition of the digestive apparatus, and that the liver was the organ most frequently at fault. The observations of subsequent practitioners have fully borne him out in this opinion, and the less frequent occurrence of the disease, and the many times it is warded off, or arrested, by early attention to those organs, fully attest the value of his observations, and the practice inculcated.

Before proceeding with the consideration of the different stages of the disease, and the symptoms characteristic of each, we shall notice the circumstances under which it is most frequently met with, and the causes which give rise to it.

In the first form of the disease which Dr. Cheyne notices, he

says:—"We find that before any characteristic signs appear, the patient for some days, or even weeks, has complained of pains in his head or belly, while at the same time he has been slightly feverish, dull, vertiginous, sallow, without appetite, or perhaps with an increased or capricious one, and with a considerable disorder in all the functions of the abdominal viscera. In some instances a dragging of one of the legs has been observed, which has led to a fruitless examination of the hip-joint and spine. In others, a very painful crick in the neck has taken place, as the first symptom of disease. These complaints arise gradually, and the child's friends are not awakened to a sense of danger until, advancing a step farther, the commencement of a specific disease has more distinctly shown itself. The dulness and severe pains are now accompanied with vomiting, usually upon getting up in the morning, or after the child has begun to stir about; yet even this symptom is often disregarded until the second or third time of its recurrence, and the disease has made considerable progress, before the illness of the patient is suspected to arise, from a disordered condition of the brain. When the attention is more particularly excited by these symptoms, the head-ache, or pain in the forehead, will be observed returning at shorter intervals. The child often affectingly complains of his head; he sighs frequently, is dull, his head requires to be supported, he complains of weariness in his eyes, the pupils appear unusually contracted, and he has an aversion to light; but in the dark, he sometimes fancies he sees flashes of light. His tongue is white, and his belly generally costive. The stools at first are of the colour of clay, but as the disease advances, they become of a gelatinous consistence, of a dark-green colour, and they have a peculiar smell, not unlike the smell of the breath in the beginning of some of the exanthemata. The pulse becomes quick, and at particular times these symptoms are attended with febrile heat and irritability, and the child complains, not of head-ache only, but of pains in different parts of the body, which are sometimes exceedingly acute. At one time he will complain of pains in his limbs, at another of pain in his breast, or in the nape of the neck, very often in his bowels, but before his friends can make any preparation to relieve him, the pain ceases, or is transferred to some other part; at another time he will lie long on his

mother's knee, restless and whining, from dull rheumatic pains. These disorders cannot last long without impairing the child's strength; accordingly, in ten days or a fortnight, the period usually occupied by the first stage of this attack, his appearance is altered, his manner becomes peevish, his hand tremulous, and his gait tottering.

"In the second variety, which is less frequent, the disease runs a more rapid course. After the child has been in a drooping state for a short time, which, although it sometimes may escape observation, is generally recollected, there is a sudden change to a fever, attended, even from the first, with a great degree of pyrexia, with frequent, but short and irregular remissions, flushing, severe head-ache, tenderness all over the abdomen, and increased sensibility, with, sometimes, brilliancy of the eyes. It is said to be often difficult immediately to distinguish hydrocephalus from fever, and this is the form in which there is the greatest resemblance between the two diseases; but we are led to suspect some deeply-seated evil, from his frantic screams and complaints of his head and belly, alternating with stupor, or rather lowness, and unwillingness to be roused; and we are struck with the great irritability of the stomach, which exists, in a degree beyond what we generally find it, in the fevers of this country, retching and vomiting being brought on by a change of posture, and certainly by every attempt to sit up in bed; and the disordered state of the bowels which attends this irritability of the stomach, is also remarkable; and when at any time the child has a little respite from the violence of these symptoms, we find our suspicions confirmed by his look, for when the features do not express pain or terror, there is not unfrequently a vacancy of look, the eyes being set with an expression of dejection which is peculiar to certain diseases of the brain."

Dr. Cheyne observed less frequently than the first case, yet more so than the second, what may be described as the third form of hydrocephalus. This last may be considered as an instance of conversion of disease, and is attended with considerable variety of symptoms:—"When hydrocephalus arises during an indifferent state of health, as for example, after there had existed a scrofulous disease which has subsided, or where, from predisposition and from the anomalism of symptoms, some such

disease might have been expected; or where the child has had some epidemic disease, as measles or scarlatina, from which he has not perfectly recovered, or regained sound health, the attack is sometimes made with all the violence which I have described as distinguishing the second form. When, again, the attack comes on as the sequel of an acute disease,—as, for instance, remittent fever, hooping-cough, dentition,—the child almost imperceptibly slips into hydrocephalus. There are scarcely any of the symptoms of the early stages, and paralysis and convulsions are sometimes the first indications of the new disorder."

These descriptions apply chiefly to the early periods of each variety; for in the later stages the symptoms become less distinctive, and there is little diversity.

Causes of Hydrocephalus.—This disease is sometimes endemic, particular localities being more subject to its occurrence than others.

Without question it is an affection more frequently attendant upon the strumous diathesis than any other; indeed, the best authorities hold, that it occurs only in children of a scrofulous habit, or born of scrofulous parents, and also that it may be directly produced by conversion of that disease from another part to the brain, not by simple metastasis of symptoms. Whatever causes, then, operate to generate or bring into activity latent scrofula, will have a tendency to induce hydrocephalus. Hence the frequency with which we find it occurring amongst the children of the very poor inhabitants of large cities, who have not had a sufficiency of wholesome food, and who generally occupy filthy and ill-ventilated houses. These causes give rise to disorder of the digestive organs and scrofula, and from these, again, springs hydrocephalus in all its forms and varieties. That such is the case, may be fairly inferred from the fact of the disease being frequently arrested in its early stages, and the symptoms removed by proper attention to relieve the disordered condition of the chylopoietic viscera.

When we meet with hydrocephalus amongst the upper classes of society, we shall generally find, either that scrofula is active in the parents or children, that there has been too great a forcing of the intellect of the child, who is, perhaps, naturally precocious, or that some of the causes which produce disordered digestion have

been in operation, such as over-feeding, improper food, irregularity in the hours for meals, badly-ventilated sleeping apartments, &c.

Hydrocephalus sometimes follows the exanthemata, measles and scarlatina more particularly; it often arises during long-continued or mis-managed remittent fever.

It is no unusual thing to hear of several children, of the same family, having been carried off by this disease, and frequently at about the same age; neither is it uncommon at this time to have individuals pointed out who were snatched from the very brink of the grave, (when labouring under hydrocephalus, or its early symptoms,) by prompt and efficient treatment. It is most certain that in families where one child may have been taken, anxiety is earlier aroused, and attention directed to the treatment of the first symptoms of the malady.

Hydrocephalus sometimes, but rarely, follows upon falls and blows received upon the head. It is very often attributed by parents to such causes, though the length of time which may have elapsed between the infliction of the injury and the appearance of the disease, will have been sufficient to allow some of the causes above-mentioned to be in operation.

I have frequently seen hydrocephalus, very rapid in its progress, though not acute as to suffering, follow long-existing diarrhœa, itself the consequence of deficient or improper nourishment.

We may say, then, that every debilitating cause, and all sources of general irritation, as dentition, may become exciting causes of this important disease.

Symptoms of Hydrocephalus.—The description already given of the manner of attack of the different varieties of this disease, has included the notice of some of the most usual and prominent symptoms. When once fairly established, hydrocephalus may be easily recognized; but its early detection is of such vital importance, and there is such a possibility of its being overlooked for some time, that I shall enumerate the symptoms in the order in which they most usually occur,—the nervous, circulatory, respiratory, and digestive systems being separately considered.

If we have been induced to observe closely the state of a child's health, either by its altered manner, or the occasional complaint of uneasy sensations and anomalous pains, and that hydrocephalus

impends, we shall perceive very much the following order of symptoms:—

Nervous System.—There will be noticed a degree of restlessness and irritability about the child's manner. Its temper will be much altered; if very young, it will not leave the mother's or nurse's arms, and even whilst therein is ill at ease, whining, and evidently distressed. The countenance betokens anxiety; the eyes are heavy, and wanting in the usual intelligent look of a healthy child; the pupils are generally preternaturally contracted, and there is an aversion to light and noise. This intolerance of light is sometimes first noticed at night, when a candle is in the room, at which an infant usually gazes fondly. The child, if in arms, often expresses sudden alarm, as if it were giddy and afraid of falling; if somewhat older, he becomes languid, and easily fatigued; declines play, and takes little pleasure in his usual amusements. He complains of pains in various parts of the body, the head, neck, the arms, and legs. The pain of the head is the most continuous; it may be in the forehead, or towards the back of the head; sometimes dull and constant, occasionally increased in violence, and often so severe as to cause the child to scream out. This occurs very frequently during sleep, when he will awake frightened and uncollected, but it is not an invariable symptom. I have seen fatal cases which were not characterized by severe pain in the head, and screaming out was not at all observed in some of them; but I have generally found, that at some period of the illness, perhaps several days before my attendance commenced, there had been some severe pain of the head, lasting, perhaps, for only an hour or two.

In one fatal case, which was under my care, the very earliest complaint of pain in the head was made whilst the child was being driven over some newly-laid-down broken stone.

Circulating System.—We shall very early perceive evidence of increased vascular action: the pulse will be some beats quicker than is natural, varying in this respect very much at different periods of examination; it is very irregular, "sometimes beating ten or twelve strokes at the rate of sixty in the minute, and the next six or eight at the rate of 100." It is greatly increased by exertion, such as sitting up in bed, and there is sometimes a wiry harshness about it. Permanently increased pulsation of the carotids

may also be generally noticed, and this, too, may be observed in the fontanelles, if still unossified.

Respiratory System.—As yet the respiratory system may not have become affected, but there will generally be observed a tendency to sighing, and there is frequently present a short, dry, hacking cough, not to be accounted for by examination of the chest.

Digestive System.—We generally find vomiting more or less constant; often pain in the bowels, which are either confined or irregularly free, the stools passed or procured by medicine being fœtid, and indicating an unhealthy bilious secretion. There may be general tenderness of the abdomen, more particularly in the hypochondriac regions; the tongue is foul, and the breath has a heavy, peculiar smell. Vomiting is a symptom usually present early, and its occurrence and frequent repetition in children should never be overlooked, which is more likely to be done in children suckling than in those more advanced. The vomiting at first may depend, in part, upon the deranged state of the stomach itself, the functions of which have been for some time imperfectly performed; but after a short time, it arises from evident sympathy, in connection with the state of the brain. This may be inferred when we observe it occurring every morning, when the child first gets up, or begins to move about. I have more than once observed vomiting two or three times in the day, with languor and altered manner, to be the very earliest symptoms indicating the approach of cerebral disease. The appetite for some time past will have been variable, and, most likely, emaciation may have taken place to a considerable extent.

Such are the symptoms most usually to be observed in the earliest stage of hydrocephalus. It must be borne in mind, however, that they will rarely be found exhibiting the regularity of grouping here presented. Some will be more prominently present and severe; others, perhaps, entirely wanting. It should also be mentioned, that there is a great tendency to irregular remission observed in many of them.

Of so very great importance is the early recognition of this insidious disease, and so much of the success of our treatment depends upon the time at which it is commenced, that I think I cannot better lead any inexperienced reader to the point we would

wish, than by quoting from Dr. West's admirable lectures the following passage:—"The painful sensations which the infant experiences soon show themselves in the haggard, anxious, or oppressed looks, which take the place of the naturally tranquil expression of its countenance. It often puts its hand to its head, or beats or rubs it, or, while lying in its cot, bores with the occiput in its pillow, owing to which, in children who have suffered for any time from uneasy sensations in the head, you will often find the hair worn off the occiput. It turns its head away from the light, and lies much with its eyes half closed, in a state of apparent drowsiness, from which it often arises with a start, and cries. The cry, especially in inflammatory disease, is peculiar; it is, generally, a low, almost constant, moan, very sad to hear, occasionally interrupted by a sharp, piercing, lamentable cry, almost a shriek. You fear that disease is going on in the brain. But is the skin hot? Is there heat of head?—are there frequent flushes of the face?—and does the accession of each flush seem connected with an increase of agitation and distress, or followed by a deepening of the drowsiness? Is the fontanelle prominent and tense, or are the pulsations of the brain to be felt with unusual force through it? Are the veins of the scalp full?—or do the carotids beat with unusual force? What is the character of the pulse? Is it, not merely increased in rapidity, but even when examined under exactly similar conditions, does it afford a different result each time? Do you find it irregular in frequency, or unequal in the force of its beats, or even distinctly intermittent? Again, what is the state of the pupil? Is it generally contracted, so as to exclude light as much as possible from the over-sensitive retina?—or is it usually dilated?—and does it act slowly, as though disease had deadened the sensibility of the nervous system?—or do the pupils of the two eyes act simultaneously, or one more readily than the other? Do the pupils oscillate under the light, at first contracting, then dilating, and either remaining dilated or continuing to oscillate, though within narrower limits, and with a tendency to remain more dilated than at first?—or, lastly, do you find, when the child is roused, this oscillation of the pupil going on under the ordinary amount of light that enters the chamber? Now, all these are indications of disordered function of the brain, and many of them point to disorder of a

very serious kind. But there are yet other sources from which we must not neglect to seek for information. Much may be learned from the state of the digestive functions; the bowels are almost always disturbed, usually, though not invariably, constipated, while nausea and vomiting are seldom absent, &c."

If we suppose the preceding symptoms to have been neglected or unrelieved, we shall be led to the consideration of the second stage of the disease—Whytt's stage of slow pulse, Cheyne's stage of diminished sensibility.

"The child appears heavy and lethargic, exhibiting a subdued manner. He is incapable of fixing his attention, and seems to wish to be let alone. He is unable to sit up, even for a short period, and, if in arms, hangs his drooping head over the mother's shoulder; exhaustion follows every exertion, mental or bodily. There is a tendency to delirium, and often a marked inclination to slumber, the child falling off in a doze immediately after having been roused to answer questions. From this doze he is often awoke by sudden starts of pain; in general, there is not much complaint of severe pain in this stage. We shall observe dilatation of the pupil, want of consent between the eyes, and imperfect, and not unfrequently double vision." There will also be noticed in infants, a continual knitting of the brows and frowning, without crying.* Convulsions are not usual in this stage, but occasionally the disease progresses so rapidly, that our division into distinct stages cannot be perceived, and convulsions will come on quickly.

Circulation.—The pulse will still be found variable and irregular generally slower than in the more advanced period, but easily doubled by any exertion. As the degree of torpor increases, the pulse also becomes slower; I have felt it so low as forty beats in the minute. There are frequent flushings, alternating with paleness. The skin is usually hot and dry.

Respiration.—The breathing is low, irregular and sighing; this latter is very constant in occurrence. You will be often struck, upon entering the room, by the deep sigh and tired method of

* M. Trousseau states, that it may be laid down as an aphorism, as seldom liable to exceptions as those of Hippocrates, that when a child sheds tears, a favourable prognosis may be delivered, however menacing the symptoms; while, when this is not the case, in painful diseases, and especially if the eyes are dry and sunken in the orbits, great danger to life exists.—*Gazette des Hôpitaux*, 1848, No. 14.

turning in bed of a child suffering from hydrocephalus. The peculiar cough is also frequently still present.

Digestive System.—Vomiting still continues, and is, perhaps, more frequent. There is not very much retching, but a peculiar kind of gulp, induced by every change of position. The matter ejected is generally mucus mixed with bile. The tongue presents a marked appearance, easily remembered when seen, but not very readily conveyed by words. It is not foul nor loaded, but lightly covered with a whitish fur, at the back and in the middle, or in patches, and, perhaps, quite clean and moist at the edges and intermediate spaces. It always conveys to my mind the idea of irritation existing in the mucous membrane, and may be more the effect of such in the alimentary canal, and of medicines exhibited, than any result of the cerebral affection. There is not in general much thirst. The bowels are now usually very much constipated, yielding only to the effects of strong purgatives; the stools present that peculiar greenish appearance, and gelatinous consistence, so well known in this disease, and before alluded to; they consist chiefly of mucus, mixed with unhealthy bile. There is sometimes suppression of urine, and dryness of the nose is also noticed. There is much to be observed in the manner of the child during this stage: the method of lying in bed, is generally on either side, one hand being placed under the head, the other, perhaps, holding the organs of generation; the incessant picking at the nose and lips, and rubbing of the former, attract our attention. This stage is most uncertain in its duration, the patient sometimes lying for many days without any decided change; sometimes he becomes rapidly worse, and a convulsion, followed by stertorous breathing, will prove fatal. The heat of the head, and tenseness of the fontanelle, are generally very remarkable about this period. I have frequently seen the body partially covered with a clammy perspiration also.

When the symptoms of the second stage have existed for a certain period, the third takes its place by imperceptible degrees. The expression of the countenance becomes vacant, the eyes are suffused, there is a hectic flush occasionally upon the cheeks; the child is, perhaps, quite insensible, or, when roused, with difficulty answers questions. There is sometimes raving. The pupil will now be found dilated and inactive; perhaps there

will be strabismus, and, most frequently, convulsions or paralysis of one side. I have seen death occur without either convulsion or paralysis; the unparalysed arm is kept in constant motion, waving backwards and forwards, or picking the nose or bed-clothes. The pulse will have become quick and thready; sometimes, especially after a convulsion, flying; the breathing hurried and irregular, presenting that character so well known in fever as cerebral breathing. As death approaches, "the face becomes purple, then sallow and marbled in complexion." Convulsions increase in frequency; there is incessant tossing of the head, and boring into the pillow. The urine is very often retained, and the bowels continue constipated. Death usually takes place during a severe convulsion, or by a gradually increasing coma. In this very advanced stage, there is to be observed a peculiar champing of the lips and jaws. I have also noticed a very remarkable avidity in the method of grasping a cup offered with drink, by the unparalysed hand and lips, and also that a child will sometimes, until within a few hours of dissolution, take greedily, and chew and swallow biscuit or bread placed within its lips.

The disappearance of flatus from the intestines will have caused a falling-in of the parieties of the abdomen, or retraction, which is generally noticed; emaciation is extreme, and the countenance has assumed an old, wrinkled appearance.

Diagnosis of Hydrocephalus.—This is a subject demanding the very closest attention we can possibly bestow. The observation of the various symptoms already enumerated and grouped, supposing them to occur with great regularity, would, no doubt, be sufficient to enable us to recognize this disease, when present, with tolerable certainty; but I must admit, and I am sure that many others, who have seen much of cerebral affections in infancy, will join me in the acknowledgment, that the diagnosis of the positive existence of hydrocephalus is often a very difficult and anxious matter. So many of the symptoms are more or less common to other diseases of as frequent occurrence, so many are sometimes wanting, or, if they have been present, may have disappeared, and often so little can be gathered from the patient himself, that we are sometimes at a loss to pronounce early upon the nature of our case. Here, again, I will repeat the advice of Dr. West, and say,—"That

we must be greatly guided by the history of the case, and the consideration of the entire of the symptoms."

Simple acute meningitis may, in general, be early known and distinguished from the tubercular form, by closely investigating the cause and history of the disease; by observing the appearance and general health of the child we have to deal with; by noticing the violence of the attack and rapid increase of bad symptoms, viz.,—very acute head-ache, delirium, coma; by the incessant vomiting, thirst, and higher fever present, almost from the first. Constipation does not form so prominent a feature of the acute attack; the aggravation of the disorder is very quickly progressive, while in the tubercular form the course is comparatively slow, irregular, and often much prolonged.

Acute meningitis has been known to prove fatal in twenty-four hours. When it follows upon any special cause, such as eruptive fever, scarlatina, for instance, that previous occurrence will form a great aid in our diagnosis.

Meningeal apoplexy and cerebral hæmorrhage are so very rarely met with in children, that they will seldom cause us much trouble. Where any obscurity exists, we may remember in those cases the irregularity and sudden accession of symptoms, the absence of quick pulse and febrile excitement, with the early supervention of convulsions and delirium. M. Legendre attempts to found a diagnosis between cerebral hæmorrhage and simple meningitis, by noticing the presence of flexions of the thumb and great toe, or carpopedal convulsions, as they have been termed, in the former cases, and their absence in the latter. I am not able, from my own experience, to say what value attaches to this as a diagnostic mark, having never had an opportunity of examining a fatal case of cerebral hæmorrhage in an infant; but I have repeatedly seen such flexures present in cases which were considered to depend merely upon the irritation of dentition, and in which recoveries took place.

Hypertrophy of the brain, and phlebitis of the sinuses of the dura mater, are very rare occurrences also; the former disease is very slow in progress, and attended with visible enlargement of the head, from a yielding of the parietes, when it occurs in the very young child, or has made much progress; a very slight attention to, and study of the case, will reveal the true nature

of the affection. I have not seen phlebitis of the sinuses, but it has been accurately described and diagnosed. When it occurs, the early symptoms are exceedingly acute, and followed soon by syncope, dilatation of the pupils, strabismus, grinding of the teeth, alternate relaxation and contraction of muscles, &c.

The diagnosis from convulsions, arising from worms and other remote causes of irritation, must be made by close attention to the history of the case, and examination of physical signs of disease elsewhere.

The convulsions which are caused by pneumonia in children, and those from spasmodic croup and spasm of the glottis, are generally accompanied by such a train of symptoms as will throw sufficient light upon their causes, and there is very little likelihood of a mistake being made as regards them.

Typhus Fever.—I have never found any great difficulty in recognizing typhus fever in children; it, however, may be mistaken for hydrocephalus, from the occurrence of head-symptoms. It is not a common disease amongst children, and seldom attacks them, unless others in the house happen to be ill of it; under which circumstances, I have seen it in children of all ages, even those at the breast. The loaded brown tongue, the suffused eyes, the constant thirst, the burning skin, the diarrhœa, petechiæ, and general absence of convulsions, paralysis, and other peculiar cerebral symptoms, usually present in the disease of the brain, will serve to distinguish between them.

Remittent Fever.—It is in this affection that we sometimes experience the greatest difficulty in forming a correct diagnosis; very many symptoms are common to the two diseases, and experience and tact alone can enable us, betimes, to draw correct inferences. Dr. Willshire says,—"Now and then, even with your greatest attention, however, you will find yourselves at a loss to diagnose between certain forms of remittent fever and particular stages of tubercular meningitis. I have, now and then, been at a loss to say, whether the head-symptoms which were present, together with much heat of skin, febrile exacerbation, and derangement of the digestive system, were really secondary to the febrile disturbance, and were to be viewed as likely to yield as the fever subsided, and that they were only evidences of temporary irritation of the nervous centre. In such

cases, I have always acted, however, very carefully, as I know that this temporary cerebral irritation and congestion of the nervous centre, not uncommon in the remittent fever of childhood, may, in a scrofulous child, lead on to perfect development of an intercurrent form of the true meningitic disorder."

Thus is the subject viewed by an experienced practical man; and from the latter part of the paragraph quoted, we may gather his conviction, that the one disease often leads to the other. In fact, the line of demarcation between them is frequently ill-defined, and a disease comparatively common in its occurrence, and not usually followed by serious consequences, becomes gradually transformed into a most dangerous and fatal malady. I would again warn those who may have charge of cases of remittent fever, to watch, closely and anxiously, every change; the less frequent the remissions, the greater danger would there seem to be of the invasion of hydrocephalus. Our diagnosis may be assisted by observing, in the former, those remissions occurring with regularity. The countenance, too, though expressive of suffering, is different from that in hydrocephalus; the lips are retracted or drawn, so as to show the teeth or gums; the countenance is pale, or sallow and sunk. The child seems to dread motion, lies on the back, with the knees bent or drawn up, and is pained by pressure on the abdomen. "Here, neither the brow is knit, nor the pupil of the eye affected." (Maunsell and Evanson.) The heat of the skin is much greater in remittent fever; the pulse, also, is quicker, and the thirst more intense; vomiting, too, is more constant. The tongue is more loaded, and sometimes is red and pointed; the evacuations are very different in remittent fever, and procured with greater ease, diarrhœa, rather than constipation, being present. The lips are generally red, chapped, and fissured, and there is often stomatitis or general abdominal tenderness. Such are the principal points of difference between the two disorders; but candour obliges me to say, that the distinction seems easier made upon paper than by the bed-side of the patient. I would take this opportunity of bearing testimony to the general accuracy of, and great value to be attached to, the observations of mothers; naturally acute, their powers of observation seem heightened by parental anxiety, and they have time and opportunities for making remarks that we cannot command. Put yourself, then, in full

and free communication with the mother; tell her what you suspect or want to ascertain, and direct her attention to the matters you wish elucidated. This will serve you far more than a "dignified reserve," and cannot injure your patient, (provided a proper time is selected for the conversation,) as might be the case were he of more mature years, and likely to be excited by being told a good deal of the doctor's opinion.

Dentition is often accompanied by the occurrence of head-symptoms, convulsions being that most commonly seen. The exanthemata, especially scarlatina and small-pox, are frequently preceded by them also. Here we must make and pronounce a most careful and guarded diagnosis. Examine accurately the state of the gums; observe if there be uneasy sleep, with frequent starting, burning hot mouth and breath, sucking the finger, or any other convenient matter within reach. Look also to the state of the bowels; these are generally loose, but the evacuations are unhealthy in appearance; a constant thirst also generally attends. In those cases in which I have seen head-symptoms antecedent to the exanthemata, delirium seemed the most prominent. There was extreme heat of skin and great restlessness; vomiting was not often present. The first appearance of the eruption is followed by some relief. If scarlatina threatens, we have the additional diagnostic marks which the peculiarity of the tongue and the smell of the breath afford. In measles, too, we may generally be assisted by observing the catarrh and derangement of the mucous membranes, which usually precede. But Dr. Willshire notices, "That we may find a difficulty in diagnosing a case of 'rubeola sine catarrho.'" Such I have lately met with in a boy of ten years.

The same authority also mentions, that "Where the exanthemata are ushered in by head-symptoms, there is not the constipation which is observed in the meningitic disorders; nor, in the younger children, the tense fontanelles."

For the means of diagnosing between hydrocephalus and the hydrencephaloid disease, we must refer to our account of that affection.

Many other causes may give rise to head-symptoms in the child, and these must be borne in mind;—worms, constipation, retention of urine, hooping-cough, acute inflammatory affections of the internal ear, (for an able account of which, see the *Dublin*

Quarterly Journal of Medical Science, for November, 1847,) and caries of the temporal bone, or suppression of a discharge from the external meatus.

The diagnosis of each and all of these must depend upon the tact and experience of the individual in charge.

Prognosis.—Owing to the additional knowledge acquired of the true nature and pathology of this disease, and the line of treatment in consequence adopted, instead of, as formerly, viewing every case in the worst possible light, we are, fortunately, enabled occasionally to pronounce a favourable prognosis. This, however, must be taken to apply only to the very early stages, and to those cases where the symptoms have been soon recognized and promptly met. All authorities, British as well as continental, look upon the disease as incurable, when fully established; still, however, as we mentioned that formerly very unpromising cases occasionally recovered, unexpectedly, now, too, we see those which have reached the second, and even third stages, with all the alarming symptoms present, sometimes rally and do well. Our prognosis, then, must be very cautious and guarded; it need never be absolutely hopeless. The very worst symptoms occurring in hydrocephalus, cannot be received as evidence of organic lesion having taken place; and whilst this is not the case, we need not entirely despair.

"When the cerebral symptoms have come on insidiously, as the sequel of a previous disease, in a child of a strumous habit, or one having a family predisposition to the disorder, much danger is to be apprehended, and the result is most frequently fatal. The more acute the inflammation, on the contrary, the greater, in general, is the chance of cure, and the better is active depletion borne, such cases usually occurring in healthy children. Recovery may also be generally effected when the disease sets in subsequently to scarlatina, if we are prepared to meet the case, as the symptoms are often very sudden and acute." (Maunsell and Evanson.)

In individual cases, we must be guided in forming our prognosis by the presence and progress of particular symptoms.

When convulsions, if they have been present, cease, or diminish in frequency and severity; when the bowels become more amenable to the action of medicine, accompanied by an improved appearance

in the evacuations; when the skin becomes moist, the urine more copious, and a watery discharge from the nose takes place; more particularly when the pulse becomes more regular in its action, and the breathing natural, we may cherish good hopes.

We must not confound the slow pulse of the second stage of the disease with a natural lowering, indicative of improvement. Indeed, it will not require very much tact to perceive a real improvement; there is generally a consonance in all the symptoms of amendment, when such occurs.

We must also remember the deceitful remission, "the lighting-up before death," and not be entrapped into raising hope, so soon to be dashed. All authors notice this occasional recovery of reason and temporary disappearance of bad symptoms. The cause of such is not easy to give, but we may mention that the same occurrence frequently takes place before death in the insane. It would seem as if two such morbid actions could not go on together in the system.

Pathology.—Much may be gathered from the preceding notice of the pathological conditions likely to be found in the brain and other organs. They may be arranged in two classes,—those arising from the presence of tubercle, and those the result of inflammation. As with the symptoms, so with the pathological appearances; they are not, by any means, uniform in their character or occurrence. All the symptoms of hydrocephalus may have been present, and its usual stages have been distinctly passed through, and still examination of the brain reveal but trifling lesion. When the symptoms have been acute, and the progress of the disease rapid, the effects of inflammation will be most apparent; and, on the contrary, when the case has been slow and rather irregular, we may expect to meet with the evidences of tubercular deposit, as well in the brain and membranes as in other parts of the body.

To the minute researches of the French pathologists we are indebted for the knowledge we possess of the early appearance of tubercular deposits in the membranes of the brain. They occur as "minute, flattened, spherical bodies, of the size of a small pin's head, or smaller, and either of a yellowish colour and rather friable under pressure, or greyish, semi-transparent, and resistant, almost exactly resembling the grey granulations, which are sometimes seen in the lungs or pleuræ of phthisical subjects."

They are also met with in an earlier stage, when they look like small opaque spots, communicating no perceptible roughness to the membranes. This appearance is observed in the arachnoid, covering the cerebellum and base of the brain. The fine grey bodies are mostly seen about the front, or imbedded in the pia mater, in the neighbourhood of the optic nerves.

The surface of the brain generally presents but trifling appearance of disease, though sometimes the convolutions are flattened and the sulci partially obliterated, by the pressure of fluid contained in the ventricles.

The appearances observed when the case has been acute, and inflammation has been decidedly present, are somewhat different. The vessels of the membranes will be found full and turgid. There is generally considerable vascularity of the pia mater; slight thickening and dulness of colour, or opacity of the arachnoid membrane, are also observed, with a dryness of that membrane, and occasionally an effusion of serum between the membranes. Lymph is also found around the vessels, and between the sulci. These changes are most apparent in the base of the brain.

When we come to cut into the substance of the brain itself, we may find it very little altered from the natural appearance. The ventricles usually contain serum, varying from two to six ounces in quantity. The cerebral substance around the ventricles is often much softened, and breaks down very readily. Dr. West describes it as having the appearance of having been "soaked in serum." The quantity of fluid found in the ventricles is very variable; sometimes we find least where most had been expected, and *vice versa;* occasionally, the quantity is so large that there would seem to have been a considerable absorption of cerebral substance. In one case, where there had been considerable pain in the left side and back of the head, I found the choroid plexus occupying the inferior cornu of the lateral ventricle of that side, enlarged, and much more vascular than the corresponding one of the other side. The cerebral substance in this case, also, appeared, when cut into, dotted with bloody points, and this, too, chiefly at the left side.

The organs in which tubercles are most frequently found, at the same time, are the lungs, bronchial glands, the spleen, liver, mesenteric glands, and intestines. "Tubercular ulceration of the

intestines," Dr. West says, "may give rise to diarrhœa; hence, constipation may not be an invariable symptom of hydrocephalus."

A morbid condition of the liver and intestinal mucous membrane has also been observed by Dr. Cheyne. He found "the intestines inflamed and constricted, as from spasms, and the surface of the liver of a bright red colour, abounding in minute vessels, and sometimes extensively adhering to the peritoneum." In many dissections, also, he found the surface of the liver studded with small white tubercles, not larger than grains of mustard. In every examination I have had an opportunity of making or assisting at, more or less distinct evidence was seen of the above pathological changes in the abdomen.

Treatment.—Although tubercular meningitis be not a disease so rapid in its progress, and so speedily destructive of life, as the acute form, nevertheless time cannot be wasted or lost with impunity, and the issue of the case will often depend upon the promptness and efficiency of our treatment. These remarks apply more particularly to those cases presenting acute inflammatory symptoms, and running a rapid course. The other class of cases, those which commence insidiously, and whose progress is slow, afford a greater opportunity for treatment, though in the main they are not more fortunate in the result. This may be accounted for, partly, by the fact of the disease having oft times made much progress before our attention has been directed to it, and its real nature been discovered, and in part, owing to the circumstance that these slow cases are those in which tubercular deposits exist to the greatest extent, and in which other scrofulous changes have taken place. Hence our usual antiphlogistic means, bleeding, mercury, &c., are less admissible, and less likely to be successful.

If the diagnosis of tubercular meningitis be occasionally difficult and obscure, we have the highest authorities agreeing that less harm generally can arise from supposing the disease to be present, and acting accordingly, than from overlooking it entirely and remaining inactive. The means, also, to be employed in the earliest stages of real disease, are those which would be most applicable to, and most likely to remove, functional disorder. I would wish, especially, to caution my readers against a practice too timid and hesitating, while doubt exists of the real nature of

the case; in other words, against a too expectant plan, or that of treating symptoms as merely functional, or arising from some cause unconnected with the state of the brain itself, until, perhaps, fatal mischief has been done, and hydrocephalus declares itself in its most unquestionable shape.

It is almost unnecessary to add, that our treatment and general management of each case must, in a great measure, depend upon, and be influenced by, the age, constitution, and temperament, of the child. Means loudly called for, and whose use would be imperative in some cases, are unnecessary, and may prove injurious in others. Hence the necessity of avoiding mere routine practice.

When called upon to visit a child supposed to be labouring under symptoms of cerebral disease, having made all necessary inquiries, our earliest attention should be directed to the state of the abdomen and alimentary canal. The operation of the first purgative given, will afford useful information, as well in exhibiting the nature and appearance of the stools obtained, (generally so characteristic in hydrocephalus,) as in enabling us to judge of the state of torpor or activity of the "primæ viæ;" and also the effects of the medicine upon the general symptoms. Some of these will at once yield after the operation of an aperient, affording grounds for considerable hope as to the issue of the case.

I almost always commence the treatment of a suspected case by giving an emetic, generally of ipecacuanha or tartar-emetic. This is, I am aware, considered by many, bold and even hazardous practice, where the head is believed to be engaged; but I can vouch for the perfect safety and great success of it. I have given the emetic very early when the case came under my observation, and again later when admissible, and never had I reason to be sorry for so doing, but more than once regretted not acting similarly. There is very frequently gastric derangement and vomiting present. The first is generally benefitted by the free action of the emetic; and the vomiting, also, even when dependent upon the state of the brain, has been checked for some time, giving opportunity for medicine to be retained upon the stomach. Tartar-emetic I generally prefer in the early stages, unless decidedly contra-indicated by great debility, or some peculiar state of the stomach itself. It certainly possesses a generally sedative and tranquillizing effect, and has often appeared to me to be most

beneficial in lowering and equalizing the circulation, and unloading the vessels of the brain, &c.

The free use of purgative medicines is very generally sanctioned, and we cannot say too much in behalf of their employment. I cannot, however, go the length of recommending that the bowels be kept acting for several days, two, three, or four times a day, by means of some powerfully cathartic medicine. I would use this valuable class of medicines more sparingly. We must recollect that keeping the digestive apparatus in such a continued state of irritation, must rapidly exhaust the strength, and we know that danger follows great debility. Let the frequency of the repetition of the purgative depend upon the necessity which may exist for it, such being judged of by the effect upon the symptoms generally, and by the appearance of the evacuations obtained. Purgatives will be more required when the stools are fœtid, copious, and abundant, than when they are scanty, and consist merely of shreddy mucus mixed with bile. I have seen mischief done by the too free use of drastic cathartics, scammony, gamboge, &c.

A combination of jalap and calomel, followed perhaps by rhubarb, with a mercurial, (calomel or hydrargyrum cum magnesia,) and these carried off by an aperient draught, with senna, &c., will generally be found active enough for very young children. Cases accompanied by great constipation may occur, requiring stronger medicines, but those mentioned will generally be sufficient. The frequency of the repetition must, of course, be determined by the circumstances above alluded to. Senna may be easily given to children in a very tasteless form, by mixing the infusion with an equal quantity of strong coffee, and sweetening as usual. When practicable, I always prescribe a purgative enema before the administration of medicine by the mouth; it will relieve the lower bowels, rendering the action of an aperient more certain and less painful. When very great irritability of the stomach exists, a drop or half a drop of Short's croton oil, placed upon the tongue, will often effectually evacuate the bowels, at the same time lessening the nausea. In such cases, Dr. Cheyne recommmends "a drachm or two of magnesia, saturated with lemon-juice, and given every second or third hour."

In every case occurring at those periods when we might suspect the process of dentition to be going on, we should examine the

state of the gums, and even though a tooth may not be felt forward enough to seem to require interference, I would never hesitate to scarify them; it removes a source of irritation, and in these cases we should leave nothing undone. Many times I have seen sound sleep follow such practice, and convulsions, which had been constantly present, disappear. It is a mistaken notion to suppose that early scarification of the gums makes the subsequent cutting of the teeth more difficult.

Another very necessary and useful point to receive attention now, is, having the head frequently sponged with cold water, and kept perfectly cool. If the child's caps have not been already discarded, seize this opportunity of laying them aside. The greatest benefit may be derived from, and great comfort bestowed upon, an infant, even when suffering from the irritation of ordinary teething, by this sponging for a few minutes at a time. I have constantly ordered its repetition several times in the day, and had it done under my own observation hourly, with the most marked relief to the little sufferer.

These evacuations and other means premised, we may now consider the propriety of abstracting blood from the system.

In strong children, or those in whom the inflammatory symptoms run high, blood-letting, local in general, may be safely practised, and will prove a most valuable antecedent and auxiliary in carrying out the purgative plan of treatment. But "the physician who recommends very free blood-letting in all cases, and he who, considering hydrocephalus as a passive dropsy, or disease purely of debility, altogether proscribes bleeding, are equally mistaken in their practice." Leeches may, in most cases, be applied to the head with advantage, the number being varied according to the age of the child and the severity of the pain. This latter, also, and its continuance, must determine the necessity for their repetition. The situation at which leeches should be applied forms a point of difference between authors. As a general rule, they may be put as near to the seat of the greatest pain as possible, viz., to the temples, when the forehead is most complained of, and to the mastoid process, when the pain is at the back of the head or towards one side. This situation has been objected to for their application, as affording an opportunity for the child rubbing them off against the pillow; but the free

communication here with the lateral sinuses, points it out as a situation peculiarly fitted for relieving the over-loaded vessels, and the liability to the leeches being rubbed off, may be obviated by keeping the child in the nurse's arms during the process. I have seen very good effects from the application of leeches to the inner canthus of the orbit, and more than once I have applied them myself to the Schneiderian membrane, with very marked relief. Whilst upon this subject, we may mention that Dr. Cheyne recommends the application of leeches to the region of the liver, to prepare the way for, and co-operate with, medicines calculated to act upon that viscus. We find, also, in Maunsell and Evanson, that "When the hydrocephalic symptoms occur, during the existence of disease of the lungs, or particularly of the digestive organs, the application of leeches over the seat of the original disorder, will often more effectually relieve the head than if they were applied directly thereto."

Bleeding from the arm may possibly be required in some very acute cases, approaching, in severity and rapidity of course, to the character of acute meningitis. Such necessity must be determined by the experience and tact of the practitioner.

We have already spoken of mercury and its utility, as an ingredient of our early purgatives; we now recommend its further use, as a medicine upon which we must place considerable reliance in the treatment of hydrocephalus. I do not mean to say that we shall observe such good effects from it in this affection, as in some other inflammatory diseases; but still I have so frequently seen benefit follow its administration, that I think it deserves a foremost place amongst our means of cure. I would not recommend its very free or speedy administration, for though salivation may not be possible in the child under three years, still harm may arise, and fatal exhaustion be produced. If the case be very acute, we may give it more freely; but the gradual continued use of it, in moderate doses, so as to affect the system, is what I recommend. To prevent undue action upon the bowels, we must combine it with opium. The fears entertained by many of the use of opium in cerebral affections, are sometimes over-strained. It is a most valuable assistant, and, with reasonable circumspection, cannot do harm.

The forms in which I generally prescribe these medicines are, calomel with opium, in very acute cases, and, more frequently,

hydrargyrum cum magnesia, with Dover's powder and James's powder. I must speak in the highest terms of hydrargyrum cum creta or magnesia with ipecacuanha, as an alterative, not only in this, but in many other diseases of children. It seems to possess peculiar powers in restoring the healthy secretions of the mucous membrane of portions of the alimentary canal, and generally acts gently, also, upon the skin.

As constipation so constantly attends the early and advanced stages of hydrocephalus, we must be prepared with means to overcome it. The frequent use of enemata is unobjectionable, and the occasional addition of a few grains of rhubarb to some of the powders above mentioned, followed by a draught of infusion of senna, with a little tincture of the same, and electuary of scammony, will be generally found sufficient for that purpose. The nauseous taste of the senna may be readily concealed by mixing it with an equal quantity of good coffee, sufficiently sweetened.

Counter-irritants.—It is a question how soon we should commence the use of these remedies. Some advocate early shaving of the head, and blistering all over, or exciting irritation by a croton-oil liniment; others prefer the application of blisters to the nape, or sinapisms to the feet and legs. I have never had reason to regret the early application of a blister to the neck, and have frequently seen much benefit from its repetition and the surface being kept open. For this purpose, mercurial ointment with savine, may be used, and we, also, gain the advantage of assisting in bringing the constitution under the mercurial influence. The biniodide of mercury, used in the form of ointment, as a counter-irritant, also possesses some advantages.*

Fomentations.—We must not persevere with the use of cold applications when coma threatens. I have seen great comfort seemingly given to the little sufferer, and sound sleep sometimes induced, by stuping the legs and feet with warm moist flannels, wrapped round again in a warm dry blanket, or piece of flannel. Stupes to the abdomen, also, are very beneficial in allaying irritation

* As a topical remedy in the form of ointment, the biniodide of mercury is applied with benefit to chronic glandular enlargements; its use, however, requires much caution, especially when applied to raw surfaces. The ointment as ordered by the "London Pharmacopœia," (biniodide of mercury, an ounce; white wax, two ounces; lard, six ounces,) is much too strong for ordinary use, and should be further diluted with three or four times its weight of lard.—Neligan, on Medicines, p. 311.

and promoting the healthy action of the bowels. Sponging the entire surface with tepid water ought not to be omitted; it comforts the child, and predisposes to perspiration.

Iodine.—Of late years, the use of iodine in the treatment of hydrocephalus has numerous advocates, as well in this country as on the continent. Many, indeed, recommend its use, almost to the exclusion of mercury. Certain it is that we cannot claim for mercury the same specific control over hydrocephalus that it possesses in some other inflammations. We know that iodine does often beneficially modify scrofulous disease; its use, then, in these cases, occurring so frequently in decidedly scrofulous patients, seems very reasonable, and has, moreover, the prestige of great names to recommend it. I have tried it, but cannot speak very decidedly of any success fairly attributable to its use. Iodine, in combination with mercury, was some time since recommended in consultation, by a friend of mine, in a case which was under my care; the form used was hydriodate of potash in solution, with corrosive sublimate made into small pills with crumb of bread. This, which was a tedious case, in a very scrofulous child, did remarkably well.

The biniodide of mercury is recommended by Maunsell and Evanson, as combining the good effects of both medicines.

During the employment of the means above enumerated, care must be taken to support the strength sufficiently, by giving good nutritious food. Broth, jelly, arrowroot, light puddings, must also be given; and when the stomach continues very irritable, enemata of broth will be found useful. Stimulants may occasionally be required, but must, of course, be given with great caution. Camphor mixture, with aromatic spirit of ammonia, will often allay vomiting, and rouse the system; even when coma has set in, such stimulants have acted most beneficially; and I have seen very good effects produced by a dose of croton oil. I once sat by the bed of a child, who, to all appearance, was sinking under the effects of hydrocephalus. There had been a gradual loss of vision, and stertor and difficult breathing seemed to indicate the supervention of coma. A blister to the nape, which vesicated well, and a dose of croton oil, which acted freely, were the means which seemed to arrest the morbid action. The boy ultimately recovered.

When the urine is scanty, which is very often the case, some-

authors recommend the use of squill and digitalis. I have not any personal acquaintance with their effects in those cases, having found other means sufficient; but I would say, that digitalis is not an easily managed medicine with children.

Prophylaxis.—This appears to be the place in which to make a few remarks as to the prophylactic means to be used when we are apprehensive of an attack of hydrocephalus in a child. Dr. West remarks, that to be successful, "we must treat the threatenings of this disease." I have watched such cases with more than ordinary care and anxiety. Where the predisposition is strong, every affection to which childhood is liable seems to be accompanied with symptoms of the malady, and they require the closest observation, and often the nicest management. Our directions cannot, of course, be other than general.

The state of the stomach and bowels should be particularly attended to. Children are prone to over-eat, and parents to give them too much. Many of their maladies arise from this cause, as I could quote case upon case to prove. Children should not have meat nearly so often as the generality of those in the upper and middle ranks are given it. The frequency should, in some respects, depend upon the opportunities they have for exercise, and being in the open air. Two, or even three, days abstinence in the week from solid meat, would do much to preserve health, and prevent the necessity for those frequent powders so much in use. If this be thought "diète absolue," let them have broth on one of the abstaining days. When weather and other circumstances permit, children should spend many hours daily in the open air; even when the weather is cold, they will often enjoy being out of doors, if sufficiently clothed; and here I must enter a protest against the modern fashion of only half clothing children. I would rather my child wanted a meal, than see it subjected to that daily starvation, from cold, to which those poor little fashionables, who trudge along with measured step, are exposed, as to their lower limbs especially.

Too little attention is generally paid to regularity of hours for giving children their meals; when practicable, an early dinner hour should be fixed on for them. Nothing requires more care than their sleeping apartment. Enter an ordinary nursery between

eight o'clock at night and the same hour in the morning. If the occupants be numerous, you find it generally very close, and ill-ventilated,—every child's bed, perhaps, furnished with its own nice curtain, and placed in the closest corner that can be selected. Here they spend half their entire time, hour after hour, inhaling a vitiated atmosphere, and slowly sowing the seeds of future disease. Let the room door be left open at night, and have a ventilator placed high up near the ceiling, opening into the flue; a hole broken will answer every purpose. Let curtains be banished from the nursery, and all useless furniture removed, and at times that the children are absent, let the windows be opened for thorough ventilation. In addition, let daily ablution be practised with every child; it keeps the skin in a healthy state, and very much lessens the liability to disease.

Where the tendency to hydrocephalus exhibits itself very strongly, either in a constitution hereditarily delicate or acquired, I would recommend the formation of an issue in the arm; and where the disease has been unequivocally present, I have seen the best effects follow an issue established at the top of the head.

CHRONIC HYDROCEPHALUS.

We cannot conclude our notice of the affections of the cerebrum in infancy and childhood, without giving a short account of dropsy of the brain, as it has been called, or chronic hydrocephalus. It is a condition of the organ not by any means so frequently met with as the acute form, and is most generally congenital, or arises very soon after birth. Many authors consider that it almost always depends upon malformation of the brain.

In some cases it may, indeed, be looked upon as a mere passive dropsy, whilst in others, and these the most numerous, we must regard it as the result of a low inflammatory condition, which may have existed for a lengthened period, and even before birth.

A child may be, apparently, born healthy, and for the first few weeks or months not attract any particuliar attention. The earliest symptoms which we notice of incipient disease, are, generally, a wasting of flesh, and a want of thriving appearance. The child loses its plumpness, and becomes soft, and this, although the appetite may be good; sometimes the appetite is even craving, and

there is a disordered condition of the bowels; they are constipated, or irregularly free. Convulsions may take place very early and frequently, and cannot be traced to any particular cause. A rolling of the head and eyes, and, perhaps, strabismus, may exist, and then, soon, an enlargement of the head will be noticed. This increases very gradually, but continuously, and is accompanied with tension of the fontanelles, and fullness of the veins of the forehead and temples. The head becomes so large and heavy, that the child is unable to support the weight of it, and it hangs to one side. In the very young child, the enlargement of the head proceeds rapidly, and to a great extent, from the ready yielding of the parietes. The disease is almost invariably fatal. Some cases are considerably protracted, and a life of misery is terminated by convulsions, or seeming exhaustion. Occasionally acute inflammation sets in, and proves the immediate cause of dissolution.

Dissection shows, that in some cases the fluid is contained in the sac of the arachnoid, constituting what is termed external hydrocephalus, whilst in the vast majority of cases, the lateral ventricles form the seat of the collection. The quantity of this fluid varies, of course, with the persistence of the disease, and the size the head may have attained. Sometimes it presents the appearance of pure limpid serum; at others, especially when symptoms of inflammation have been present long before death, it appears turbid, with flocculi of lymph in it.

The lining membrane of the ventricles becomes changed. Dr. West says,—"Even when no false membrane is formed within the ventricles, their lining often presents other evidence, besides mere thickening, of its having been the seat of inflammation: it is roughened, and granular, presenting an appearance closely resembling shagreen, and communicating a very perceptible roughness to the finger. All parts do not seem equally liable to undergo this change; but I have observed it to be much more marked about the corpora striata than elsewhere."

Regarding the mode of treatment, very little can be said in favour of the success of any particular plan. Some cases are decidedly and hopelessly incurable. In these, very frequently recurring convulsions and paralysis will be present. Those in which there is some likelihood of cure, are characterized by simple enlargement of the head, without much convulsive action.

Gölis recommends "that the hair be kept closely cut, and that one or two drachms of mild mercurial ointment be rubbed daily into the scalp; at the same time, from a quarter to half a grain of calomel should be given twice a-day, unless diarrhœa come on, when the inunction alone must be performed."

Blisters to the nape, occasional leeching, if there be much heat of head, and the administration of a purgative, now and then, seem to be the chief means upon which any reliance can be placed. A couple of small issues in the back of the neck may also be of service, by keeping up a long-continued drain.

Mr. Barnard, of Bath, has recommended, and spoken highly of the success attending a mode of bandaging the head, so as to make pressure upon the parietes of the cranium, and prevent their further expansion.

Puncture of the cranium, and evacuation of the fluid collected, have also been practised. The extreme difficulty of determining, with any degree of accuracy, the situation of this fluid, whether within the ventricles or external to them, must form an insuperable objection to the adoption of this means; and, unfortunately, the recorded results of cases thus treated, do not justify its general recommendation.

On the whole, chronic hydrocephalus is one of that class of diseases which it is so very painful to the physician to be occasionally obliged to witness through their various stages. He can scarcely either give or indulge in hope of a favourable termination, and sometimes, even when apparent recovery may take place, the intellect will remain in a permanently weakened condition.

We must here conclude our sketch of the principal "Cerebral Affections of Infancy." It is necessarily brief, and, we fear, may be thought imperfect in some particulars; but it did not aim at the character of a complete work—it was only an essay. Most attention was bestowed upon those affections which occur with the greatest frequency, and on this account, the subject of "water on the brain" claimed considerable space.

If any useful hints have been given, either as to the prevention of this disease, or its treatment when established, the author will feel much gratified.

He would again, before taking leave, beg to remind parents and

those who have the charge of children, that they have much in their own power. Let them avoid those causes which have been alluded to as predisposing, and a sound constitution and vigorous understanding will often take the place of delicate physical and weakened intellectual development.

"The fabric of the human mind is curious and wonderful as well as that of the human body. The faculties of the one are with no less wisdom adapted to their several ends than the organs of the other; and the better we are acquainted with their nature and uses, their defects and disorders, the more skilfully, and with the greater success, shall we apply the resources of the healing art to their treatment."

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ON

ANÆSTHESIA AND ANÆSTHETIC SUBSTANCES GENERALLY;

BEING

AN EXPERIMENTAL INQUIRY INTO THEIR NATURE, PROPERTIES, AND ACTION, THEIR COMPARATIVE VALUE AND DANGER, AND THE BEST MEANS OF COUNTERACTING THE EFFECT OF AN OVER DOSE.

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It is not the object of the present essay to enter upon the subject of the discovery of the effects of sulphuric ether and its allied bodies when inhaled by animals, nor to give any history of their introduction into use, nor to attempt to determine the disputed question by whom they were introduced. Neither is it proposed to determine their advantages or disadvantages in any particular case; nor the propriety of administering either ether, chloroform, or any other anæsthetic substance, in any particular class of cases, though these are considerations which cannot be altogether overlooked. The practical application of these agents is a most important question, and one that deserves to be well and thoroughly investigated; in fact, it is too important to be discussed otherwise than as a primary and separate inquiry. But I must confess it appears to me that as yet the information which has been before the profession is neither sufficiently extensive, nor of that precise character which is absolutely necessary to enable us to arrive at an accurate and certain conclusion as to their practical value, and the circumstances in which, and under which, they, or any of them, should be employed or not: in fact, hitherto their use has been mainly, if not altogether empirical,—not founded upon any rational basis. The intention of the present

inquiry is to assist in affording that information, and to furnish evidence from which such inferences and deductions may be fairly drawn, as shall, if possible, render their practical application as safe and certain as the nature of the case admits. For this purpose we require facts to guide us. The inquiry is therefore strictly experimental, and has been undertaken for the purpose of ascertaining:—

1. If the property of inducing anæsthesia be confined to the few substances which have hitherto been used, or if there be not a large class of bodies which have in common the property of temporarily suspending consciousness or sensibility, or both, vitality remaining; and if this be so, whether these substances are characterized by any similar composition or chemical alliance, and have a common *modus operandi* upon animal bodies?

2. What their *modus operandi* is? or, in other words, upon what structures do they act? what changes do they produce? what are their physiological effects? is their primary effect local or general?

3. Is there any one of these substances which should be selected in preference to, or to the exclusion of, all the others? Is there any one, the temporary effects of which are more complete and certain, the permanent more harmless, and its administration more under our control, than those of any of the others, that we should uniformly retain the employment of it, and reject the use of them?

4. Is there any essential difference in the action of these substances according to the mode in which they are administered? Do they produce the same effects in whatever way they are carried into the body, or does the effect depend upon the nature of the tissue upon which they are applied? and does the same dose, when applied to the same tissue, and in the same manner, invariably produce the same uniform results?

5. Are there any symptoms by which we may accurately judge of their effects, and ascertain and control the point to which the system may with safety be brought under their influence?

6. In case of an overdose, are there any means which can be employed to counteract the effects? Do we possess any antidotes, or are there any remedies? If so, what are they, in what manner do they act, and how should they be employed?

It is obvious these propositions embrace a very wide field of inquiry, and equally so that each of them might be subdivided into distinct heads. It is not presumed, nor implied, that the answers to all of them, or perhaps any one of them, are complete and satisfactory; but those who have been in the habit of making similar experiments upon animals, and attempting to define the exact relation which chemical substances, whether employed therapeutically or poisonously, bear to the animal economy, and who consequently are the best qualified to judge, will, I have no doubt, readily admit, that however imperfect the answers are, and however small may be the addition to our previous knowledge, the inquiry, conducted as it has been, amidst the interruptions of constant and active professional engagements, has not been accomplished without a considerable expenditure of time and labour; and they will therefore most readily, if not overlook, at least look indulgently, at faults, whether of commission or omission. If it does nothing else, it will lighten the labours of other investigators.

Nearly all of the substances which hitherto have been mentioned as anæsthetics, are compounds of the hypothetical radical ethyle—the assumed base of ether; substances which are formed of hydrogen and carbon united with oxygen, as an oxide of ethyle—sulphuric ether; or of this oxide, playing the part of a base, in combination with an acid, as nitric ether; or of hydrogen and carbon united with chlorine, instead of oxygen — chloroform, the most marked chemical character of these bodies being that they are all hydro-carbons. One other substance of somewhat analogous character has been mentioned, and shewn to possess, to some extent, similar properties, in which the hydrogen has been replaced by sulphur—the bisulphuret of carbon.

From reflecting upon this circumstance, I was, some time ago, led to the supposition that not improbably many other bodies might be found to possess similar powers, possibly even in a more advantageous form than some already known, since the use of these appears, so to speak, to have been rather accidental and fortuitous, than the consequence of any reasoning upon their nature and mode of operating. In fact, it appeared to me, that where hydrogen and carbon might be supposed to constitute an hypothetical radical or base, whether as ethyle, acetyle, methyle,

or some other modification, they might be combined with another body; which third body might be replaced by another element, the properties of the compound remaining, to a great extent, the same. Thus, as ether is an anæsthetic, and composed of hydrogen and carbon, united with oxygen, which even may act as a base, and unite with an acid, one acid being capable of substitution in the place of another, the general character of an ether fluid remaining; and as chloroform is also an anæsthetic, in which the oxygen has disappeared and chlorine been substituted, so it appeared not only possible, but even highly probably, that this might be again replaced by iodine, nitrogen, sulphur, or some other element, the new compound in property being analogous, if not identical, with the old. That this is true, at least to some extent, is proved by the fact of hydrocyanic acid, a compound of nitrogen, carbon and hydrogen, being a most powerful anæsthetic agent, perhaps the most powerful yet tried.

This, it will at once be perceived, is in some degree an extension of the beautiful theory of substitutions, now so generally admitted amongst chemists, applying the same doctrine to the therapeutic and physiological properties of isomorphous bodies, as has so long been known to prevail in their chemical qualities.

In pursuing the inquiry, I was led to endeavour to ascertain the truth of the converse proposition as to the different properties of bodies composed of the same elements in the same proportion, but possessing different chemical and physical qualities—isomeric bodies, of which the hydro-carbons under consideration form, perhaps, the most extensive class, many of them not differing materially in their ultimate analysis, while they are very diversified in their physical qualities. However this may be, as we know too little of the manner in which many of these substances are actually united, notwithstanding the laborious investigations and ingenious hypotheses of chemists, it seemed only proper that other substances, composed mainly of hydrogen and carbon, in combination with another element, should be tried; accordingly, the subjoined list of substances tried will be found to contain several of these; the number might be almost indefinitely extended. Some of the bodies with which I had a strong desire to have experimented, from their rarity and the difficulty of making them, I found it impossible to procure, many being described by chemists

rather on hypothetical grounds, than from their actual existence. Others are so unstable in their composition, that it is impossible to preserve them; the affinity between their elements is so slight, that they are no sooner made than they are decomposed, hence they could never be practically valuable whatever their action; while others, from their irritating properties, are useless. Some, as hydrocyanic acid and conia, are so destructive to life, as to be too dangerous to use; while, again, many others do not possess that property of volatility, or the solubility by which they can be made volatile, which is essential to their action: they are not isomorphous with the ether compounds.

Besides these triple compounds, I thought it not unadvisable to try the effects of some of the pure hydro-carbons, as naphtha, turpentine, &c., and some of the bi-elementary gaseous bodies, as being most allied to the compounds which possess anæsthetic power, thinking this very power might possibly be dependent upon their containing these elements. One of these gases, if it did not actually suggest the idea to the introducers of these agents, certainly produces such effects, when inhaled by man, that, with our present knowledge, some persons have expressed wonder that it did not lead its adventurous and glorious discoverer, Davy, to the full development of the idea of which he undoubtedly had the conception. It affords another most striking illustration of the observation, that no great and wonderful truth all at once bursts upon the world, but that it is always preceded by various and portentous foreshadowings, which, like the hand-writing upon the wall, only require the skill of the prophetic seer, or the wand of genius, to develop to mankind.

Having ascertained that in order to possess anæsthetic powers, it was not necessary for a body to have a triple composition, but that some of the bi-elementary compounds also were endowed with it in a high degree, I was desirous of determining, if possible, if one element alone possessed the power, and if so, which of them; or if the combination of two or more be essential, of which in particular is the presence required. The only way to ascertain this was to exhibit, in succession, substances with one or more of the elements changed, it being impossible to present all of them in an uncompounded form, in that condition necessary for inhalation, or even for absorption; accordingly the list contains substances

which some, at first sight, may be surprised at finding there. They were examined, not only on their own account, but for the purpose of presenting bodies in which each of the elements entering into the constitution of a known anæsthetic was in succession removed, in order, by as an exact an analysis as I could adopt, to examine each one element, and determine if it were essential or not to the possession of anæsthetic power; with what success, we shall be better able to speak after going over the details. The difficulties in arriving at a positive conclusion are considerable; but I may mention the results prove that oxygen, chlorine, hydrogen, and nitrogen may be excluded, and yet we shall put an animal into a complete state of anæsthesia. This, however, will also be more advantageously considered in the answer to the first question, which is given near the end of this inquiry: to pursue the subject further now would only be to imperfectly anticipate and occasion needless repetition.

The substances tried, and of which the effects are detailed in this essay, are:—

Chloroform,
Alcohol,
Spiritus vini of the Pharmacopœia,
Sulphuric ether,
Spiritus ætheris nitrici, Ph. L.,
Nitric ether,
Acetic ether,
Chloric ether,
Chloroform and spirit of wine, mixed,
Hydrochloric ether,
Hydriodic ether,
Hydrobromic ether,
Dutch oil, or chloride of olefiant gas,
Oleum æthereum, Ph. L.,
Heavy oil of wine,
Aldehyde;
Two or more of these mixed together.

Iodoform,
Olefiant gas,
Light carburetted hydrogen,
Coal gas,
Benzole,
Camphor,
Naphtha, (three varieties of,)
Oil of turpentine,
Creosote,
Protoxide of nitrogen,
Hydrocyanic acid,
Coneine,
Hydrogen,
Carbonic acid,
Carbonic oxide,
Bisulphuret of carbon,
Sulphuretted hydrogen,
Bromoform.

The mode of administration has been by:—

1. Inhalation, in various degrees of concentration, for a limited period.
2. Inhalation for a prolonged period.
3. Internal administration, by the stomach and rectum.
4. Injection into the veins.
5. Limited application to the skin—local action.

The post-mortem appearances are given in each experiment when death has been occasioned.

A trial of various remedies, and presumed antidotes follows.

The animals submitted to experiment have been taken from the four classes of the vertebral division, and also some of the invertebrata have been used, though, for several reasons, dogs and cats have been principally employed; yet the variety has been sufficient to shew that, without much exposing ourselves to the charge of unwarrantably generalizing, we may affirm the effect throughout the animal kingdom to be uniformly of the same kind, and therefore that we are fully justified in considering it would (as indeed with many we know to be the case,) be the same in man, and consequently, in applying the practical inferences to him, we are not very liable to be wrong.

The whole of the experiments will be detailed first, then will follow such remarks as the effects of each substance individually appear to call for, and afterwards the general inferences and conclusions which I think may be fairly and legitimately deduced from them, will be mentioned in the form of answers to the queries before propounded. In doing this, two methods of arrangement might be adopted, either to bring under one head the effects of all the agents upon one kind of animal, or the effects of one agent upon all the animals. The latter is that principally followed, as possessing more advantages than the first, though it necessarily involves some repetition in relating the different experiments. With the animals we shall begin with the highest, and follow a descending scale.

Some may not improbably think the effects have been related with unnecessary length and minuteness, more especially in those substances, as chloroform, which have now been so frequently used in surgical practice, and with which almost every practitioner may be supposed to be familiar; but it must be borne in mind that this inquiry has been going on for a considerable period. At the time many of these experiments were made, but little was known of its effects; and even now, the general terms which have been proposed, as 1st, 2nd, 3rd, and 4th degrees of narcotism, to indicate the extent to which the animal is brought under the influence of the anæsthetic, are only arbitrary, having no fixed signification, by no means universally adopted, and

probably by no means generally understood; besides which, if a comparison is to be made between the effects of different substances and the experiments detailed, so that each may form his own inferences, (as is my intention,) it is necessary to relate the effects of all in the same manner.

I may mention that in no one instance was the record left to memory; in every case, as the experiment proceeded, were the effects written down on the spot. This may have often led to a want of elegance in the expression used, or to a want of correspondence in the mode of expression; but as I consider these defects to be more than counterbalanced by the exactitude ensured, I have been less scrupulous in generally retaining the observations as penned at the time.

It is not a matter of great moment which substance we take first, perhaps nearly the order in which they stand above, in which, for the most part, their chemical affinities are to, at least some extent, preserved, is as good as any. Chloroform, which from its importance and general use is excepted from this arrangement, may be taken first. Then might follow the chloride of olefiant gas, which, in smell and general appearance, as well as in containing chlorine, bears a strong relation to chloroform, but inasmuch as in composition it differs materially from it, and approaches nearer to the ether group, I have placed it among these. It may be proper here to mention, as the reason of my trying this fluid with considerable expectation of success, the fact that while it presented such general resemblance to chloroform, it contained so much less of chlorine and more of carbon and hydrogen, appearing to present that composition which, if my theory be correct, would endow it with those qualities most to be desired in a greater degree than chloroform.

CHLOROFORM.

Perchloride of Formyle—(Comp. C_2HCl_3. Boils at 140° F. Sp. gr. of liquid, 1.480; of vapour, 4.2.)

No. 1.—A strong terrier bitch inhaled one drachm of chloroform from a sponge wrung out of water; temperature 80°. Instantly she began to struggle very hard, and in one minute became

insensible and perfectly still. The sponge was continued to the mouth for five minutes; after the first minute the only motion observed was a very faint moving of the ribs, and the heart could be felt very feebly beating. Immediately the sponge was removed a faint throbbing motion could be perceived in the muscles, at the base of the tongue, which gradually increased and extended to the face and head. At nine minutes she was convulsed, and at twelve was so far recovered as to be able to get up and sit, propped by the wall, white foam dribbling from her mouth. At eighteen minutes she could stand, but not walk, being upset with the least touch; her occupation then was to rub her face and neck, first on one side and then the other, violently upon the floor and mats, as though the parts itched much.

No. 2.—The same dog as last, twenty-four hours after, being quite recovered. Sponge dipped in warm water as before, and one drachm and a-half of chloroform given. She struggled hard for a minute, then lay perfectly still, so that it was difficult to say whether there was any respiration or not until three minutes and three-quarters, but the heart could be felt acting feebly and quickly; when for about fifteen seconds she breathed rapidly, and with a convulsive noise, then lay perfectly still until five minutes, without any respiration or pulsation of the heart, when the sponge was removed, still smelling strongly of chloroform; soon after which, both water and liquid fæces in small quantity dribbled away—*dead.*

No. 3.—Same dog as had thirty minims by the mouth, being perfectly well. Thirty minims of chloroform were given by respiration, by means of a broad, very thin sponge; temperature, 68°. At first she struggled violently against it, but soon breathed deeply and laboriously, with the saliva running from the mouth; in two minutes and a quarter there was neither sensation nor reflex action, but she made a whining noise; at six minutes she was perfectly motionless, except the muscles of respiration, and this act was accompanied with a puffing, smoking distension of the cheeks, which continued during a minute; at eight minutes no pulsation of the arteries or heart could be felt. The sponge was held to the nose up to the fifteenth minute, but the dog did not give any indication of life after the eighth minute.

Post-mortem examination twenty-four hours after death.—Body perfectly rigid; muscles natural in colour. Head: vessels of the

dura mater, pia-mater, and the brain, all congested; otherwise this was natural. Chest: lungs appeared congested, and nearly scarlet in colour, but little collapsed; the left (she had lain upon the left side,) perfectly infiltrated; bronchial membrane not much injected. Left side of the heart contained but very little blood, the aorta nearly empty; both right cavities enormously distended with black, or nearly black, coagulum, venæ cavæ and pulmonary artery, but especially the former, were very full of dark fluid blood, as were all the abdominal veins. Bladder empty. No effusion in any of the cavities.

No. 4.—A young bull terrier, about six months old, inhaled one drachm of chloroform from sponge; temperature, 68° Fahr. At first, as usual, struggled against it, but very soon became quiet; and in one minute and a-half there was neither sensation nor reflex action. The sponge was kept to the nose for ten minutes, but the heart could not be felt to move after five minutes; only faint motion continued to be perceived about the throat until six minutes and a-half. He did not move the limbs after two minutes; the respiration was deep and prolonged, with considerable blowing motion of the lips, about which mucus collected.

Post-mortem examination twenty-four hours after death.—Head: pia mater congested, brain natural. Chest: lungs, brick-red in colour, and apparently congested; bronchial tubes completely up to lower part of trachea filled with white frothy mucus; bronchial membrane not injected at all: heart, right ventricle and auricle, distended, with a soft, dark coagulum; venæ cavæ much distended; left ventricle contained a soft coagulum of the size of a walnut; auricle quite contracted and empty; pulmonary artery contained fluid blood, but was not excessively distended; pulmonary veins also contained fluid blood; aorta held a small quantity of blood. The arteries generally were empty, but the veins all contained blood; the abdominal veins were much injected. Bladder contained urine. The stomach and intestines were distended with food.

No. 5.—I applied by means of a damp, warm sponge, thirty minims of chloroform to the mouth of an active terrier dog. At first it struggled hard, but in thirty seconds became quiet and breathed deeply, with dilated pupils; the saliva freely dribbling from the mouth. The sponge was retained over the mouth and

nose during five minutes, when the chloroform being exhausted, it was removed; the dog was not insensible, and when let loose, immediately ran about and rubbed his neck and body very violently, as No. 1. After seven minutes a second dose of thirty minims was administered in a precisely similar manner to the first; in two minutes and a quarter there was neither sensation nor reflex action, but an indication of distress by the noise in breathing; at six minutes there was panting respiration, with blowing motion of the cheeks, all the other muscles being perfectly motionless and flaccid. The heart could just be perceived with a quick, fluttering motion, until nine minutes, after which there was no indication of life.

Post-mortem examination made twenty minutes after the heart could be felt to move.—The appearances were so similar to those in No. 4, that it is unnecessary to repeat them.

No. 6.—Same dog as No. 59, to which the nitric ether had been given. After some time, when the dog had perfectly recovered, fifty minims of chloroform were given in the same manner upon the same sponge. There was scarcely any struggling; he breathed deeply, with faint cries, during one minute; and before two minutes, he was quite dead.

Post-mortem examination eighteen hours after death.—Body rigid. Head: vessels of the pia mater congested, those of the substance of the brain but little so. Chest: lungs collapsed and red, somewhat livid at the posterior part: heart not distended, the cavities all being contracted, those of the right side containing more blood than those of the left; venæ cavæ much distended with nearly black fluid blood; aorta and pulmonary artery empty; pulmonary veins contained some blood; the substance of the heart firm; its own vessels (as is frequently the case after death from chloroform,) distended. There was no effusion either in the pericardium or pleura.

No. 7.—A strong, but not very large, rough-haired water-dog, inhaled from a sponge wrung out of water, temperature, 120°, seventy minims of chloroform. He inspired deeply and quickly, so as to inhale it rapidly; he struggled hard at first, but became affected in a minute; never lost sensation nor sensibility. The sponge was removed at five minutes, before which time the whole of the chloroform was exhausted. The only effect was

that he appeared rather weak on the legs, and rubbed his neck and breast with considerable force upon the floor. In a quarter of an hour experiment repeated; temperature of water 100°. Did not struggle so much as last time, and breathed steadily and deeply. The sponge was removed at five minutes, the chloroform being completely exhausted; unable to stand or move; no sensation, but reflex action remained; at nine minutes, muscular power returning, as is sensibility; twelve minutes, can now see; eighteen minutes, able to run, but falls every now and then, the muscles being tremulous and weak. In twenty-two minutes afterwards experiment repeated; struggled very little; not insensible until the expiration of five minutes, when he lay perfectly helpless without sensation, but gradually recovered. In twenty-five minutes afterwards experiment repeated; at three minutes, respiration became quick and stertorous, then more feeble; sponge removed in five minutes, as in the other experiments, the chloroform being exhausted; dropped insensible and motionless, except respiring quickly, but feebly, the heart pulsating rapidly; in fourteen minutes could see, and perceive the indications of a threatened blow, but was unable to move; at eighteen minutes began to move, and in twenty minutes was able to stand, with the legs very straddling and wide apart. The motions bore a strong resemblance to those of an animal recovering from prussic acid. For twenty-four hours after he appeared dull, and not disposed to eat much; on the following day he made his escape, being perfectly well and active again.

No. 8.—An old mongrel terrier dog, weighing about twenty-one pounds, had one drachm of chloroform given to him upon a sponge, which had been wrung as dry as possible, out of water of the temperature of 120°. He continued to struggle hard for two minutes, and made several attempts to howl; at three minutes he became perfectly flaccid; after which he did not stir, nor was there any respiration or pulsation of the heart. The sponge was not removed from the nose until five minutes, but there had not been any sign of life after three minutes; the chloroform was not exhausted.

Post-mortem examination forty-eight hours after death.—Head: the vessels of the membrane and brain congested; otherwise, brain natural. Chest: lungs nearly black, from congestion; bronchial

membrane much congested: left auricle and ventricle of the heart contracted, and nearly empty, as was also the aorta; right auricle and ventricle contained a little dark fluid blood; pulmonary artery contained some, but was not distended by, dark fluid blood. The venæ cavæ, and indeed the veins generally, filled with dark fluid blood. Bladder contained urine.

No. 9.—A very large, strong, bull terrier bitch had given, by inhalation upon a sponge, at 60° Fahr., eighty minims of chloroform; she resisted very hard. The sponge was retained over the mouth for ten minutes; though sensation and motion were lost, reflex action was not, and respiration continued; before the expiration of the ten minutes, both sensation and motion were returning. When let loose, she was very weak, and it was five minutes before she could stand; at first she appeared disposed to be very ill-tempered and savage, but shortly became calm. At the expiration of fifteen minutes, after having been put into the open air and made, though very unwillingly, to walk about, forty minims more of chloroform were given in the same manner. The sponge was continued to the muzzle for five minutes, when the chloroform was all exhausted. The effect of the application and the subsequent recovery were much the same as in the first instance. The hind legs appeared to be more affected, and to be longer in recovering than the fore legs.

No. 10.—Same dog as last, twenty-four hours afterwards; temperature, 20° lower than last night. The sponge, containing one drachm and a-half of chloroform, applied to the muzzle for ten minutes; she did not wholly lose sensation, but breathed very laboriously; and when let go, laid down for four minutes, then walked away, and was soon quite well.

No. 11.—Same dog as last; two days (forty-eight hours,) after, inhaled one drachm and a-half of chloroform from a large, thin sponge, sufficient to cover the whole of the mouth. Struggled very violently at first; gradually became quiet, and apparently lost sensation, but not altogether reflex action nor motion, until eight minutes, when she appeared to be gradually recovering. One drachm more of chloroform was put upon the sponge; this occasioned very violent struggling, but she gradually became quiet; sensation and reflex action were lost for a short time; the fæces were passed. At thirteen minutes, the effects had

considerably subsided, and one drachm more was given; there was not much struggling after it; she became quite insensible, and respiration, which had hitherto been extremely laborious, became much fainter, and the heart's action very feeble and quick; the urine was copiously passed. At twenty minutes, as she appeared gradually recovering, another drachm was given: she immediately became quiet and perfectly insensible, with respiration slow, and heart's action very feeble, but still continued to move her head. At twenty-five minutes, improving, one drachm more was given, which did not produce any decided effect, but the respiration gradually became slower, and the urine was again passed. The heart did not entirely cease to beat, but at thirty minutes, when the sponge was removed, she had not respired for one minute. She lay perfectly motionless at first, and apparently more insensible than she had been whilst inhaling. The respiration gradually became more frequent; the muscles became tense; the four extremities were very rigidly extended, and the head and neck drawn backwards as in complete opisthotonos; there was no sensation nor perception until five minutes after she had ceased to breathe the chloroform. Convulsions now came on in rapid succession; she gradually became more sensible, and lay rolling from side to side until fifteen minutes; but it was not until twenty-five minutes after that she was able to support herself, and at the expiration of thirty minutes she was only able to walk, reeling like a drunken person, being, however, perfectly conscious. As she recovered, there was a great dribbling of saliva, and an indisposition to move, with an evident feeling of coolness.

No. 12.—The same dog as last; three days (seventy-two hours,) after, was made to inhale one drachm and a-half of chloroform from a large sponge, which had previously been steeped in water, at a temperature of 100°. Stomach not quite empty. Took it very quietly and determinately, evidently attempting not to inspire for about a minute, when, unable to resist inspiration any longer, she began to struggle most violently. At two minutes and a-half, neither sensation nor reflex action; three minutes, breathed very feebly and slowly; four minutes, no respiration nor motion of the heart perceptible; six minutes, a little spasmodic action about the throat and diaphragm perceptible, which lasted

about twenty seconds; this was the only motion perceived after four minutes. At eight minutes the sponge was removed, having still a strong odour of chloroform. During her struggles a large quantity of flatus was passed per anum, and about six minutes, a little urine, and a small nodule of fæces which rested in the anus.

Post-mortem examination in half an hour, not having given the least indication of life.—Head: brain excessively congested; the vessels of the cerebrum and cerebellum filled with blood, those of the pia mater and the sinuses enormously distended with dark brick-red fluid blood, which flowed out very freely. Chest: lungs dark red from congestion, but much collapsed; mucous membrane of the trachea, like all the other membranes, congested, but not covered with mucus: heart enormously distended, especially on the right side; the venæ cavæ excessively filled; the pulmonary veins filled, but not excessively; pulmonary artery filled; aorta and large arteries contained some blood; blood upon the left side of the heart, dark dirty red, and quite fluid; on the right side, black and coagulated. Abdominal viscera all greatly congested. Bladder contained a little water, and the rectum some fæces. Muscles all very dark, and on cutting through, showed not the faintest traces of any quivering.

No. 13.—A full-grown, but rather small, cat was put into a covered glass vessel, holding three hundred and seventy-five cubic inches, with one drachm of chloroform. She immediately became uneasy and tried to escape, the saliva dribbling freely from her mouth. In half a minute she became perfectly still, supported against the side of the vessel. There was some convulsive cough. At three minutes, the only motion was that of very feeble, rapid respiration, sixty per minute; the pupils dilated. At three minutes and a-half, respiration had ceased, when the cover of the jar was removed, the cat being apparently dead; but on being handled, she, for a few times, breathed in a short barking manner. At five minutes, there was neither sensation nor reflex action, the muscles being perfectly flaccid; but by thrusting the hand beneath the ribs, the heart could be felt very feebly beating at one hundred and twenty per minute. At ten minutes, there was perceived a very faint convulsion, which was immediately followed by rapid twitchings over the whole body; at twelve minutes, on being taken

from the vessel and laid upon the floor, she immediately began to cough and respire, and reflex action returned; the urine and fæces were passed, and shortly afterwards the convulsions were very strong. She now began to swear, and, though unable to crawl or stand, made most violent attempts to bite the floor, and everything put near the mouth, more viciously than I ever saw a cat bite. This continued for ten minutes, during which time she improved so as to be able to crawl about, attacking most furiously everything, so as to render it prudent to get out of her way; even her own tail she apparently mistook for something else, and bit most vigorously. By twenty-six minutes this temper had subsided, and she then as earnestly sought to be caressed and petted. At half an hour she eagerly eat meat, and though weak, could walk about. The next morning she was quite well.

No. 14.—Same cat as No. 13. Put one drachm of chloroform upon a damp, warm sponge, at 80° Fahr., and held it over the mouth and nose. For a minute she struggled hard, then became suddenly perfectly still. At one minute and a-half, there was neither sensation nor reflex action; at three minutes, there was a little grunting noise, after which not any indication of life. The chloroform was not nearly exhausted.

Post-mortem examination in half an hour after the chloroform had been given.—The head perfectly natural; no congestion of the sinuses, of the vessels of the pia-mater, nor of the brain. Chest: not any motion of the heart; blood all fluid, and of a dark brick-red colour; the left cavities of the heart contained but little blood, as did the aorta; the right were distended, but not excessively so; the venæ cavæ and pulmonary artery full. Lungs red and congested, but collapsed. Abdominal viscera natural; their veins not particularly congested. Bladder contained urine. No effusion in any of the cavities.

No. 15.—A very large powerful cat, had one drachm of chloroform given upon a warm damp sponge, at a temperature of 70° Fahr. She struggled very hard indeed against it for one minute and a-half, when she became still, and sensation appeared to be lost; but reflex action was not completely so until ten minutes. She continued to breathe feebly until four minutes, and the heart slightly to pulsate until five minutes; after

which there was no sign of life. The sponge was removed, still retaining a considerable portion of the chloroform.

Post-mortem examination forty-eight hours after death, the weather being rather cold for the time of year, June.—Head: the sinuses and the vessels of the pia mater somewhat congested, the brain being natural. Chest: lungs excessively congested; membrane of larynx and trachea injected, but containing little mucus: heart, both auricles and ventricles contained some partly coagulated blood, but no part of the heart was distended; the blood on the *right* side was *very dark* in colour, but on the *left* side was *black*. The abdominal veins, and the uterine especially, were excessively distended.

No. 16.—A full-grown cat inhaled not quite one drachm and a-half of chloroform from sponge. She immediately struggled hard, and passed urine in a stream of considerable force. In one minute and a-half sensation and reflex action were quite lost; she lay perfectly still without respiring, but the heart beating rather rapidly until five minutes, when there was some little respiratory movement, which gradually became very rapid, during which time the pulsations of the heart became excessively quick, amounting to nearly three hundred per minute, as far as could be counted; at seven minutes, some sensation and reflex action had returned. The sponge was removed from the mouth at ten minutes. She lay across the knee as though asleep, but with motive power gradually returning, and gradually awakening, when she slipped off the knee and sat crouched down, and for awhile she was indisposed to move, but in a short time was quite well again.

No. 17.—To the same cat as last, two days afterwards, and being perfectly recovered, I gave, by inhalation, in the same manner as before, forty minims of chloroform. In one minute and a-quarter, sensation and reflex action were lost; she continued to lie still and breathe quickly and slowly until five minutes, when for a minute the respiration became rather spasmodic, after which it ceased. The heart could just be felt moving until eight minutes, after which there was no indication of life.

Post-mortem examination forty-eight hours after death, temperature being low for the summer.—Head: vessels both of the membranes and the brain somewhat congested. Chest: the lungs were of a bright scarlet colour, except in two or three places where there

was apoplexy; the bronchial tubes contained but little mucus, and the membrane was not much injected. Heart: the right auricle and ventricle distended, the former very much so; the left auricle contained some blood, the ventricle but very little, and it was contracted. The blood was black, and but slightly coagulated. The abdominal veins were much distended. The bladder and rectum were both full.

No. 18.—A kitten, twelve or fourteen days old, was put into a covered jar holding eight pints and a-half, with twelve minims of chloroform. In one minute it became affected, and rolled from side to side; in two minutes it lay in a deep sleep, but on the ear being pinched, it immediately started up and rolled about for a minute, when it again fell asleep, breathing quietly, and only moving to coil itself up as cats do when sleepy; taken out at five minutes. It lay quite still asleep for twenty-five minutes, when it roused up, but could not crawl until five minutes more, when it was very weak, and had a convulsive tremulousness for some time. It quite recovered.

No. 19.—A kitten, of the same age, was placed in a similar jar, with thirty minims of chloroform. Its struggles immediately were violent, gradually, however, ceasing at two minutes, when it was still and insensible, breathing feebly until twelve minutes, when its respiration could not be perceived; but the heart could be felt pulsating with some force. It was taken out at fifteen minutes, perfectly flaccid and insensible; respiration gradually returned; at the expiration of a quarter of an hour it could cry and move. The next morning it was well.

No. 20.—A kitten, three days old, was placed in a sixty-inch jar, with four minims of chloroform. It struggled hard at first, but in three minutes was perfectly motionless, lying as though asleep, with a low moaning noise, and perfectly insensible to pain. At twenty minutes it was taken out, not having stirred, and apparently now dead; but in one minute it feebly respired and gradually improved, and in an hour and a-half had recovered. Two hours and a-half after being taken out, and apparently perfectly well, it was returned to the jar, with ten minims of chloroform. It struggled hard for one minute, then became perfectly still; at thirty minutes, had not moved, was wholly insensible, and breathed very feebly; at sixty minutes, had not moved, and for some time had ceased to breathe; taken out dead.

No. 21.—A six-weeks'-old rabbit was put into a gallon jar, with ten minims of chloroform, at a temperature of 68° Fahr. At three minutes it appeared comfortably going to sleep, but at five minutes it fell upon its side, cried out a good deal, and had convulsive movements of the limbs for five minutes, when it became quiet and lay still, but did not altogether lose sensation. On being removed at fifteen minutes, it immediately revived, and was soon well.

No. 22.—A rabbit, a month old, was placed in a gallon jar, with twenty minims of chloroform, at a temperature of 68°. In half a minute it made very violent attempts to escape, which it continued for a minute, breathing quickly; it then fell, and after two minutes, when it cried out, it did not stir nor give any indication of life. Taken out at five minutes, dead. I fancied I could feel the least fluttering of the heart, but was not certain. It very soon became rigid.

No. 23.—A sparrow was put into a ninety-inch jar, with four minims of chloroform, at a temperature of 66°. It was immediately affected, and fell backwards. It scarcely stirred; and when removed at one minute and a-quarter, it was dead; for rigidity directly began, and in less than half an hour it was quite stiff.

No. 24.—A very large and strong toad, just taken out of water, (consequently with the skin wet,) was put into a jar holding sixty cubic inches, with ten minims of chloroform. It struggled very hard for half a minute, then became still, and afterwards scarcely moved. Taken out at ten minutes, dead, and had been so for some minutes.

No. 25.—A small carp *(Cyprinus Gibelio,)* was placed in a seven-ounce oval jar, just sufficient to allow it to lie, with five minims of chloroform, and allowed to remain in during ten minutes, at a temperature of 60°. It at first jumped convulsively, then became perfectly still, and did not move after four minutes. When put into water it immediately recovered, and swam actively about; but in an hour afterwards it appeared weak and dull. There was a large effusion of mucus. Next day it was well.

Another carp was placed in a jar, with seven minims of chloroform. It also leapt convulsively at first, then became still, and so remained until twelve minutes, when it was most violently

convulsed for a minute; it was again still until fifteen minutes, when it was put into water, and swam actively about, with much effusion of mucus; otherwise quite well, and continued so.

A third carp was put into a similar jar, with ten minims of chloroform. It lay almost still, being less convulsed than the last; and when, at the expiration of fifteen minutes, it was put into water, it swam actively about. Ten hours afterwards, it appeared natural; but in fourteen hours it was lying upon its side, and could not balance itself. In two hours more, it was dead.

No. 26.—A large carp was put into a jar, with just sufficient water to allow it to swim about in, (about twenty-four ounces,) to which was added ten minims of chloroform; temperature, 60°. The effects were very similar to those of hydrocyanic acid. It became alternately very active and still; being almost motionless, then suddenly dashing violently about the water, but becoming weaker. In fifteen minutes it was perfectly still, not respiring, and floating upon its side or back. Put into pure water, but it did not show any sign of life.

No. 27.—Chloroform is extremely destructive to amphibia, as the following will shew. A rather small newt *(Lacerta aquatica,)* was put into a jar, into which four minims of chloroform were dropped. It *instantly* was violently convulsed, and almost immediately was dead. Even a single drop is sufficient to produce this effect. Two minims put into a small portion of water, in which the creature is placed, will produce the same effect, though not quite so instantaneously. Young frogs are similarly affected.

No. 28.—A *Blatta orientalis* (cockroach,) was put into an ounce jar, with three minims of alcohol. For the first moment it was prostrated, but in a very short time it was as well as ever. Three other minims were then put in without more than momentarily affecting its activity; afterwards one minim of chloroform was put in, the insect instantly dropped, struggling upon its back; and in three minutes it was dead.

No. 29.—A very large spider was put into an ounce jar, up the side of which it was actively running, when a *very small* drop of chloroform was allowed to fall in. The spider instantly rolled to the bottom of the jar, started to run up the side again,

but faltered, fell, became motionless, and dead. These experiments were repeated more than once, with a similar result.

No. 30.—Three black slugs *(Limax ater,)* were put into a four-ounce jar, and allowed to crawl upon the sides of the jar, when six minims of chloroform were put into it. In less than one minute they fell to the bottom, and shrunk up into less than half their previous size, being covered with an exudation of thick mucus. They did not stir, and when taken out at five minutes, the only sign of life, even on being pricked with a needle, was a little motion in the tentacula. In half an hour, on being pricked, they slightly moved, but soon afterwards died. So great was the contraction of the cloak, that the alimentary canal protruded from both the anus and mouth.

No. 31.—A *Limax ater* was put into a six-ounce jar, with two minims of chloroform. It instantly appeared to suffer considerably. It became covered with thick, tenacious, yellowish mucus, much lessened in size, hard and contracted, and very soon was dead.

No. 32.—A black slug, while crawling upon the side of a jar, with the respiratory orifice open, had a very small drop (not more than half a minim) of chloroform put into the opening. The slug *instantly* curled up, shrank in size, threw out thick mucus from the foot, presently fell to the bottom of the jar, and was dead in almost as short a time as is required to write this paragraph.

No. 33.—A house slug *(Limax variegatus,)* crawling in a similar way, I attempted to put a drop of chloroform in the orifice, but it closed it too rapidly to allow it to pass in. The slug appeared to suffer pain, shrank in size, threw out mucus as the last, and became still and insensible; but in a few minutes it was again crawling about. In fifteen minutes a drop was put into the opening, with the same effect as in the last, except that after a few minutes it moved a little, but soon died.

No. 34.—Another slug was allowed to crawl about until the respiratory orifice was opened widely, when a very small drop (not more than half a minim) of chloroform was let into the opening. It *instantly* fell, and did not afterwards stir.

Similar experiments were made upon snails *(Helix hortensis* and *nemoralis,)* with a like result. These were frequently repeated,

as were corresponding ones, with sulphuric ether, nitric ether, acetic ether, oil of wine, and bisulphuret of carbon, (some of which are detailed in their proper places,) all of which showed, in the most decided manner, the much greater destructive character of chloroform than the compounds of ethyle; next to these was the bisulphuret of carbon.

No. 35 and 36.—In order to ascertain if any of the effects were dependant upon the confinement in the jars and vitiation of the air, I put a kitten in a two hundred and forty-inch jar, and a young dog in a three hundred and seventy-five-inch jar, and covered them over in the usual manner. They were each allowed to remain in the jars for upwards of an hour and a half without any effect being produced. It may here be stated that in all cases where the animal was kept a considerable period in a vessel, the covering was so placed as not to entirely exclude all change of air: either, if it were a glass shade, it was placed over a narrow crevice in the table, as, for instance, over the joint where the leaf is attached to the body of the table; or if in a jar, a small aperture was left uncovered, but care was taken to leave only a small aperture.

ALCOHOL.

(Comp. $C_4H_6O_2$. Boils at 172° F. Sp. gr. of liquid, 0.796, at 60° F.; of vapour, 1.6133.)

No. 37.—A full-grown cat was placed in a six-hundred-cubic-inch jar, temperature, 60°, with one drachm of pure alcohol, of specific gravity 0.797, and kept in half an hour. The only effect was a little slavering and rather hurried respiration; otherwise, at thirty minutes, as well as when put in.

No. 38.—A very large rabbit, of the Spanish breed, was put into a jar of the same size, with forty minims of alcohol. When taken out at twenty minutes, it was unaffected.

No. 39.—The same rabbit, three days afterwards, was put into the same jar, with two drachms of alcohol, and kept in upwards of half an hour. The respiration was hurried, but no other effect was produced. He jumped about as well as ever,

on being taken out. There was a large quantity of vapour given off while in the jar.

The following experiments were made with rectified spirits of wine, sixty-four overproof, being equal to about ninety per cent. of absolute alcohol:—

No. 40.—A kitten, two months old, was put into a jar holding two hundred and forty cubic inches, temperature 65°, with one drachm of spirits of wine. The jar was covered over, but not so as altogether to exclude change of air. It made some little attempt to escape, and the saliva dribbled freely away; it then sat still, and appeared rather sleepy, but perfectly easy and comfortable. It was taken out at the expiration of two hours, perhaps rather unsteady, but it ran off quickly enough, and did not at any time exhibit the slightest appearance of insensibility.

No. 41.—A cat, rather more than half-grown, was put under a glass shade holding six hundred cubic inches. It was placed over a narrow fissure in the table, so as to allow of some change in the air. Temperature, 65°. Pieces of bibulous paper were then saturated with three drachms of spirits of wine. She made but little attempt to escape, and after a few minutes sat still, looking dull. In fifteen minutes a live sparrow was introduced: she sat and looked somewhat vacantly at it for three or four minutes as it moved about, even allowing it to perch upon her back, then suddenly sprang upon it, killed, and immediately eat it. She could not be hungry, as only just before being put under the shade she had eaten three sparrows. When taken out, at the end of two hours, she was rather unsteady, but perfectly sensible, and walked away very deliberately. The heart beat quickly and throbbingly, which it continued for some time to do.

No. 42.—A strong young dog was placed within the same six-hundred-cubic-inch shade, under the same circumstances, four drachms of spirit being used. At first he slavered, and tried to escape, but soon became quiet and laid down, looking sleepy. At the expiration of one hour and a quarter he had recovered from this, and was taken out perfectly well.

No. 43.—A six-weeks'-old rabbit was placed in a jar holding two hundred and forty cubic inches, with a drachm of spirit.

It was allowed to remain in half an hour without being in any way affected. Temperature, 68° Fahr.

No. 44.—A black slug (*Limax ater*,) was put into a six-ounce jar, with six minims of spirit. In five minutes it was taken out, still and contracted, apparently dead; but a slight motion could be seen in a portion of one of the tentacula, which was not retracted. The next morning it was dull and contracted, and did not appear to have moved during the night; but on being pinched, it stirred. Died during the day.

SULPHURIC ETHER.

ETHER—OXIDE OF ETHYLE.—(Comp. C_4H_5O. Boils at 96°. F. Sp. gr. of liquid at 68°, 0.7154; of vapour, 2.565.)

No. 45.—A four-months'-old dog had a drachm and a-half of sulphuric ether upon a moist sponge, at a temperature of 65°. He did not struggle much, and became insensible in two minutes. In three minutes and a-half he whined a little, and became less insensible; at six minutes he had become quite sensible, and the ether all exhausted. When let go, he was able to walk very staggeringly about the room, and in a few minutes was quite well again.

No. 46.—A nearly full-grown terrier dog was put into a thousand-cubic-inch jar, with two drachms of sulphuric ether, at a temperature of 75°. He immediately made attempts to escape and howled, which continued for three minutes, when he became unable to stand, and insensible in five minutes. The ether being exhausted, another drachm and a-half was put in, the temperature having fallen to 65°. He continued to move and howl until ten minutes, then became perfectly still; but he breathed until fifteen minutes, and in twenty minutes was taken out dead.

Post-mortem examination immediately.—Chest: lungs shrunk in size, dark red in colour and feeling solid, and when cut into, appeared dry; pulmonary veins full; venæ cavæ excessively distended; some little effusion in the pericardium, which was going on from the surface of the heart, which, when wiped dry, immediately became moist: heart uncontracted; all the cavities

contained fluid blood, very dark brown, nearly black; alike on both sides, but none of the cavities were greatly distended; the aorta and pulmonary artery were both full; no injection of bronchial membrane, nor any mucus even in the smallest bronchi. Head: sinuses of dura mater not congested; vessels of pia-mater rather congested, as were those of the brain; a good deal of serum effused, both on the surface and in the ventricles. Blood globules seen under the microscope; those from the brain natural; from the heart and liver perhaps a little irregular, and rather granular, but not much different from those taken from the ear of another dog for the purpose of comparison.

No. 47.—A kitten, twelve or fourteen days old, was placed in a covered jar holding two hundred and fifty cubic inches, with thirty-five minims of sulphuric ether. It was not much affected for two minutes, when it began to slaver a good deal, and struggled convulsively until four minutes, when it fell upon the side and lay still, breathing quickly but quietly, though it was not insensible for twenty minutes. When another kitten mewed, it appeared to hear the cries, and joined vigorously in them. At thirty-five minutes it was removed, being very weak, and just able to crawl a step or two; but in a quarter of an hour appeared recovered. It was returned to the jar, with one drachm of sulphuric ether. It immediately cried and struggled hard, gradually becoming quieter until three minutes, when it was fast asleep, and lay so, insensible, until fifty minutes, at which time sensation was returning; and on being handled, it roused up a little. On being taken out, it soon became able to crawl about. The next day it appeared tolerably well, but looked thin; and on the following day died.

No. 48.—A kitten, six weeks old, was put into a two-hundred-and-fifty-cubic-inch jar, with forty minims of sulphuric ether. Temperature, 65° Fahr. It was fully one minute and a-half before any sensible effect was produced. It then struggled somewhat, gradually becoming quieter and insensible, and lay in a deep sleep, without sensation, but occasionally moving during an hour, when it was removed. It was now very dull, yet it could see and move, though much indisposed to do so at first; but in five minutes it was very slowly crawling about. Two hours and a-quarter after, it had as nearly as possible recovered,

the breath still smelling strongly of the ether. The next day the kitten was perfectly well.

No. 49.—A kitten, three days old, was put into a sixty-inch jar, with four minims of sulphuric ether; it was unaffected. In ten minutes, ten minims more ether were added; it became rather quieter for two minutes, but by no means still. In twenty minutes, another ten minims of the ether were put in without any material effect. When taken out, it continued to cry for some time. Four hours and a-half after it was returned to the jar, with thirty minims of ether; it cried out and struggled much for three minutes, then became still, with a low moaning noise, but in a very short time roused up, very little affected. In ten minutes, another thirty minims were put into the jar with little effect, and at thirty minutes, again thirty minims were given; in five minutes after which it lay still, except a moaning noise, but was not insensible to pain. At an hour it lay still, with very laborious breathing, and required a sharp pinch to be made to feel. At an hour and a-half it was lying in the same condition, when it was taken out. It almost immediately roused up, and in five minutes afterwards, on being placed in a box, it was making efforts to get over the side of it. It was now put into a jar (sixty inches) with five minims of chloroform; in three minutes it was lying motionless, insensible, and without respiration; nor did it afterwards show any signs of life. Taken out at ten minutes dead.

No. 50.—A six-weeks'-old rabbit was put into a gallon jar, with thirty minims of sulphuric ether. It immediately cried out loudly, then sat perfectly still, apparently unaffected, until six minutes, when it suddenly fell upon its side, and feebly cried out. It lay breathing quickly, but otherwise was motionless, until fifteen minutes, when it was removed, perfectly flaccid and powerless, not entirely, but nearly without sensation and reflex action. In a quarter of an hour it had, in a great degree, recovered, but appeared dull and weak.

No. 51.—A sparrow was put into a ninety-cubic-inch jar, with ten minims of sulphuric ether; temperature, 66° Fahr. It was affected in a similar manner, and in the same time, as No. 125, the only difference being that it did not continue quite so long nor so soundly asleep as No. 125; for after an hour, on some bread

crumbs being put into the cage, with some noise, it immediately woke up, hopped down, and began to eat. The next morning it was lying dead, rigid, and cold.

No. 52.—A carp, *(Cyprinus Gibelio,)* of small size, was put into an oval seven-ounce jar, with five minims of sulphuric ether, (temperature, 60°,) and kept in during ten minutes. It continued to move and to breathe during the whole time, but before being removed, it had become very dull. On being put into water, it immediately swam naturally about, and continued to do so, the only effect being the effusion of a large quantity of mucus.

No. 53.—A larger carp was put into just sufficient water to allow it to swim about, (twenty-four ounces,) with ten minims of sulphuric ether, and allowed to remain in during an hour. It continued swimming actively about, but in forty-five minutes its breathing had become laborious and jerking, though it was perfectly sensible. In sixty minutes it was dashing convulsively about the water, evidently under the influence of the ether. On being placed in pure water, it appeared perfectly natural.

No. 54.—A small carp was placed in a jar, with thirty-two ounces of water, (temperature, 60°,) which allowed it to swim about, with thirty minims of sulphuric ether. In half an hour, for a few minutes, it dashed rather violently about the water; but this soon subsided, and in two hours it was a little weak and dull, with mucus effused. There was no other effect. It was kept in the covered jar during forty hours, being perfectly well.

No. 55.—A large, strong toad, with a wet skin, was put into a sixty-cubic-inch jar, with ten minims of sulphuric ether. It did not suffer, but became gradually dull. At twelve minutes, on being taken out, it could still crawl. It was immediately returned to the jar, and allowed to remain for an hour and a quarter, during the last half of which time it had not moved, and appeared to be quite dead; but on putting it in an empty jar, I fancied it did just stir one leg, though it was so slight, that I could not say whether it were alive or not. It was altogether insensible, unconscious, and without reflex action. The next morning, to my surprise, I found it able to move, and conscious. It quite recovered before night.

No. 56.— A black slug *(Limax ater,)* was put into a six-ounce

jar, with six minims of sulphuric ether. It soon became insensible to pricking, soft, and flaccid, with a moderate quantity of effused mucus. When taken out at forty minutes it was very dull, and nearly motionless, remaining so for half an hour; but it gradually recovered, and the next morning was as well as ever.

The action of sulphuric ether upon reptiles and mollusca is not so powerful nor so destructive as that of chloroform. This is especially the case when they are in water. Not only is a larger dose required, but they will live a longer time than with chloroform. Possibly the less solubility of the ether may in part account for this,* though, as there is a difference when in air, this of itself is not sufficient.

SPIRIT OF NITRIC ETHER.

A Mixture of Hyponitrous Ether, Alcohol, and Water, in unascertained proportions.—(Sp. gr., 0.834.)

No. 57.—A six-weeks'-old rabbit was placed in a two-hundred-and-forty-cubic-inch jar, with a drachm of spirit of nitric ether. After remaining in half an hour, it was taken out not in any way affected. Temperature, 68°.

No. 58.—A half-grown cat was placed in a six-hundred-cubic-inch jar, with three drachms of spirit of nitric ether; temperature, 65°. She was taken out, after remaining in forty minutes, unaffected.

NITRIC ETHER.

(Comp. $C_4H_5O + NO_5$. Boils at 185°. Sp. gr. of liquid, 1.112; of vapour, not exactly known, but heavy.)

No. 59.—I gave to a full-grown, but not very large, spaniel, by means of a large sponge, one drachm and a-half of nitric ether, which had become in a slight degree acid; temperature, 66°. The sponge was held to the mouth and nose for five minutes.

* It is stated in some works that chloroform is insoluble in water. This is not quite correct. Though by no means very miscible, yet it communicates in so considerable a degree its sweet and pungent taste to water, that there can be no question as to its solubility to a certain extent.

At first there was some, but not very violent, struggling; sensation was rendered dull, but not destroyed; he could both see and walk. After ten minutes the experiment was repeated, with two drachms of nitric ether. The dog did not appear to dislike it. In three minutes he became still, and almost insensible to pain, though vision was not altogether lost. He was made to respire it for eight minutes. The heart was then beating quickly, but with some little power; he appeared insensible to pain, and at first could not walk, but very soon was able to do so. After five minutes, the effects of the ether had in a great degree disappeared. They appeared to be very transient.

No. 60.—A month-old rabbit was put into a gallon jar, with twenty minims of nitric ether; temperature, 65°. It was immediately affected, and tried convulsively to escape; breathed quickly, staggered, and fell several times. It then became still and sleepy, but when taken out in half an hour, it was quite well and active.

No. 61.—Experiment repeated, with another rabbit of the same size, and with thirty minims of nitric ether. It did not exhibit any uneasiness, but gradually fell asleep, falling upon its side. On being taken out, at half an hour, it was quite unable to stand or sit. Sensation, though blunted, was not destroyed; and on handling, it in a short time roused up.

No. 62.—A sparrow was put into a ninety-inch jar, with ten minims of nitric ether; temperature, 66°. Almost immediately it began to breathe quickly and to roll about. This continued with a sort of sharp, short chirp, for three minutes, when it became perfectly still, and, in fact, dead; for on being taken out at five minutes, it gave not the least signs of life, and in half an hour was perfectly rigid.

No. 63.—Three slugs (*Limax ater,*) were respectively put into four-ounce jars; into one jar was put two minims of nitric ether, into the second four minims, and into the third eight; they were all kept in the jars eight minutes. They appeared to suffer, and became very soon completely covered with mucus. At first they moved about, but shortly were perfectly still, and exceedingly soft and lax, especially the two last. In half an hour after being removed, there was some little motion perceptible in them, but they soon after died.

Similar experiments were made with three snails, (*Helix marmorata.*) They all died.

No. 64.—A drop of nitric ether was allowed to fall upon the open respiratory orifice of a black slug. It writhed, as though in pain, became covered with mucus over its entire mantle, kept the orifice tightly closed, and was soon motionless and senseless, but gradually recovered, and remained well. A similar experiment was made with a snail, which died.

No. 65.—One cockroach was put into an ounce jar, with two minims of nitric ether, another with four, and a third with eight minims. The first became dull, but not altogether motionless nor insensible, the other two did in five minutes; these both died, but the first recovered. A *Blatta lethifera*, with four minims, in five minutes became perfectly motionless and insensible; but in half an hour it was able to walk about, not much the worse.

These creatures are tenacious of life. I not unfrequently found that after lying for hours quite motionless, they would recover, even after they were thought to be dead. This was the case after the ether, more especially the *oleum æthereum*, but not after either chloroform or bisulphuret of carbon.

ACETIC ETHER.

Acetate of Oxide of Ethyle.—(Comp. $C_4H_5O + C_4H_3O_3$. Boils at 165°. Sp. gr. at 60° 0.89.)

No. 66.—An old, but rather small, mongrel dog, was placed in a large jar holding two thousand one hundred and twenty cubic inches, with two drachms of acetic ether, at a temperature of 70°. It was but little affected for a quarter of an hour, when it lay down and soon was fast asleep, and so continued during half an hour, not stirring, except it was disturbed, when it was perfectly sensible. On being taken out, it appeared dull and weak, but was able to walk about, and was willing to eat.

No. 67.—A full-grown cat was placed in a six-hundred-inch jar, with forty minims of acetic ether. In half a minute she was affected; the saliva dropped from the mouth, the eyes and nostrils were much irritated, and their secretions much increased. She sat leaning against the side of the jar without stirring for

a quarter of an hour, when she lay down, breathing laboriously, but otherwise motionless, and asleep. When taken out, she was dull and weak, with the heart beating very feebly and rapidly. She could walk, but was so disposed to lie still, that she required forcing to stir. She did not lose sensation nor consciousness.

No. 68.—A full-grown cat was placed in a six-hundred-cubic-inch jar, (temperature, 62°,) with one drachm of acetic ether. She was soon affected; saliva flowed freely, and there was much distress, with attempts to escape, and a little convulsion; in a quarter of an hour she was quite insensible, and so continued until half an hour, when she was taken out; the breathing was regular. A wound in the foot bled freely, the blood being rather lighter than natural. Sensation and consciousness soon returned on being taken out.

No. 69.—A kitten, six weeks old, was put into a similar jar, with forty minims of acetic ether. In fifteen seconds it was affected, and for one minute and a half made most violent attempts to escape; it then gradually became quieter, and in four minutes lay quietly sleeping, but breathing rather laboriously. Taken out at the end of an hour, having been quite insensible, and with very little motion. In half an hour, on being handled, it uttered a few very feeble cries, and the heart beat rapidly, with scarcely any power. Two hours and a half; has lain perfectly motionless, except breathing regularly and laboriously, having cried (apparently involuntarily,) a few times, and being altogether insensible in the extremities, but sensible about the head and neck. It passed urine. After lying for twelve hours nearly motionless, it died, never having rallied.

No. 70.—A kitten, twelve or fourteen days old, was put into a two-hundred-and-fifty-cubic-inch jar, with thirty-five minims of acetic ether. It was affected in forty seconds; in eighty, it could not rise, but lay struggling and crying until two minutes and a-half, when it fell comfortably asleep upon its side, but was not insensible until eighteen minutes; it then became completely so. It continued perfectly motionless, its respiration becoming slower and more laborious, with saliva dribbling from the mouth, until one hour, when it was removed from the jar. In half an hour after, it continued in exactly the same condition—motionless, except the slow respiration, and cold. It was put

with other kittens in a warm place for the night. In the morning it was somewhat revived, but could not swallow even when milk was put into the mouth, and looked very thin and distressed. In the course of the day it died.

No. 71.—A kitten, three days old, was put into a sixty-inch jar, with four minims of acetic ether. It immediately struggled, and in one minute the saliva was freely running from the mouth, with a constant putting out of the tongue, and motioning as though trying to avoid something disagreeable. In three minutes, it lay asleep, motionless, with a low moaning noise, but was not insensible to pain; in twenty minutes, it had nearly recovered from the effects, and was taken out; the fæces had been passed. In two hours and a-half, being quite recovered, it was returned to the jar, with fifteen minims of acetic ether, which had evidently an irritating effect upon the mouth and nostrils, but in two minutes it was perfectly still, and continued so until nearly twenty minutes, when it was recovering, and could perceive pain. At thirty minutes, fifteen minims more ether were given, which induced considerable struggling and crying for three minutes, after which it became perfectly still and insensible, and so continued until one hour and a-half, when it was taken out, breathing very slowly. Having lain for thirty minutes after being taken out, breathing fully, and making (with expiration) a feeble cry, but without any motion whatever in the limbs, it was put into the same jar as No. 20 had been, no fresh chloroform, however, being added; there was still some unexhausted, though it could but be very little. In thirty seconds it was dead.

No. 72.—A sparrow was put into a ninety-inch jar, with ten minims of acetic ether; temperature, 66°. Its respiration was immediately quickened; it staggered and fell about the jar, becoming more helpless until four minutes, when it lay, with the exception of respiring, until seven minutes, motionless. When removed, it was altogether insensible, reflex action being lost, the only sign of life being very rapid panting respiration. Immediately it was taken from the jar, the inspirations became much deeper; in four minutes it moved slightly, and in less than half an hour it could sit upon the perch. The next day it was as well as ever, and so continued.

No. 73.—A large and strong toad, the skin being wet, was

put into a sixty-cubic-inch jar, with ten minims of acetic ether. It struggled hard for one minute, then became nearly quiet, and in three minutes perfectly so, except occasional gaspings. In ten minutes it was taken out dead.

No. 74.—A carp, *(Cyprinus Gibelio,)* of small size, was put into an oval seven-ounce jar, (dry,) with five minims of acetic ether, temperature, 60°, and allowed to remain in ten minutes. It immediately leapt about most violently, but after three minutes it was nearly still. When placed in water, it for a few minutes lay very still, and seemed as though about to die, but after ten minutes it rallied and swam actively about; in an hour it appeared perfectly well. A large quantity of mucus was effused.

No. 75.—A larger carp was placed in just sufficient water to allow it to swim about, with ten minims of acetic ether, temperature, 60°, and kept in during an hour. It soon became dull and very weak, more decidedly so than the corresponding carp in sulphuric ether, in a like quantity of water, but on being put into pure water, could swim, though it was very quiet, and appeared sickly. It recovered.

No. 76.—A small carp was placed in a covered jar, containing thirty-two ounces of water, which allowed it to swim about, with thirty minims of acetic ether; temperature, 60°. The water was agitated, so as to mix the ether with it. At the expiration of two hours, when left for the night, the fish appeared nearly natural, perhaps a little dull, with some mucus effused; but it was perfectly sensible, and swam about as usual. The next morning, eight hours after, it was floating on the surface, quite dead. It was not rigid, nor did it become so.

No. 77.—A small black slug had one drop of acetic ether put into the respiratory orifice. It instantly became perfectly still, then threw out mucus, presently twisted about, as though in pain, and crawled off not much the worse. In a quarter of an hour the experiment was repeated with the same effect. When quite recovered, a very small drop of chloroform was put into the orifice; the slug instantly fell, and did not afterwards stir.

No. 78.—A black slug was placed in a six-ounce jar, with six minims of acetic ether. It was shortly dead, much lessened in size, and hard, with considerable effusion of yellow mucus.

Acetic ether is very destructive to amphibia, far more so than

sulphuric ether, and nearly as much so as chloroform. If a newt or young frog be placed in a jar, and one drop of acetic ether put in, in the space of a minute it will not unfrequently be dead; or if the creature be put into a small quantity of water, two or three drops are sufficient very quickly to kill it.

CHLORIC ETHER.

Chloroform and Spirit.

The account of chloric ether, which from its smell, appearance, and properties, I suspected to be a compound of chloroform and spirit, is so imperfect and unsatisfactory in Turner, and some other books on chemistry, that I asked Mr. Mawson, as a maker of it, to be good enough to tell me its composition. He replied, "Chloric ether is a compound of chloroform and alcohol, differing from the former as nitric ether from sweet spirits of nitre."

No. 79.—A young, but full-grown, mongrel dog, had two drachms of chloric ether given upon the sponge, wrung out of water, at a temperature of 95°. He made very little resistance; in one minute and a-half was quite still, and so continued until four minutes and a-half, during which time he was perfectly insensible. The heart acted, and respiration continued to go on regularly. At five minutes, the ether being exhausted, he began to rally, and the sponge was removed. He walked away for the first few yards staggeringly, and then as well as ever. The fæces were very soon voluntarily passed.

No. 80.—A three-quarter-grown cat was placed in a six-hundred-cubic-inch jar, with a drachm and a-half of chloric ether. In one minute begins to slaver; seven minutes, has sat still, slavering, and gradually becoming sleepy and weak; she now sits rolling from one side of the jar to the other; ten minutes, asleep at the bottom of the jar. Up to fifteen minutes, she occasionally somewhat roused up, not altogether insensible, but looked very foolish and vacant, and on pressure upon the feet and tail, or on their being cut, she made no effort to withdraw them; but on being sharply pricked two or three times in succession, she gave some slight movement of the head. Twenty-five minutes,

has up to this time lain perfectly still, motionless, and altogether insensible; now removed, when she immediately improved; in eight minutes was able to stand, and the heart was beating more slowly and with more power.

No. 81.—The same kitten as had the wood spirit forty-eight hours before, having continued very dull, weak, and inactive ever since, was put into a six-hundred-cubic-inch jar, with a drachm of chloric ether; temperature, 60°. It gradually became sleepy, perfectly easy, and still. In fifteen minutes it could not support itself, but sank down, and rose up again frequently; at twenty minutes it sank into a profound sleep, and was perfectly insensible. When taken out, at twenty-three minutes, it lay perfectly still for three minutes, then moved the limbs, but continued exceedingly weak for a long time; indeed, it was weak to begin with.

No. 82.—A full-grown male cat was placed in a six-hundred-cubic-inch jar, with two drachms of chloric ether; temperature, 74°. For three minutes he sat perfectly still, thence to five minutes turned constantly round, as wishing to escape, but made no violent struggles, gradually becoming sleepy, and by ten minutes was lying doubled up in a most unnatural position, very soundly asleep, so he continued up to twenty minutes; he was not absolutely insensible, but very nearly so. By very severe pinching, or sharp pricking, he was somewhat roused, and appeared much displeased at being disturbed. Another drachm was now put in, which immediately excited him for two minutes, when he again fell soundly asleep, and in five minutes was perfectly insensible, and continued so until the expiration of an hour, when he was taken out; he was then utterly without any muscular power, but was beginning to feel a little on being pricked. He gradually, but slowly, improved, and though sensible when put away for the night, at the expiration of half an hour he was still unable to stand, but appeared to be perfectly comfortable.

No. 83.—A three-quarter-grown cat was placed in a six-hundred-cubic-inch jar, with a drachm of chloric ether; temperature, 60°. She soon became affected, gradually became sleepy, and in five minutes was soundly asleep at the bottom of the jar, quite insensible, and so continued, breathing rather laboriously, until the expiration of an hour and a-half; she was altogether unconscious

when taken out. The heart was beating with pretty good power. She almost immediately became conscious, and staggered away under the grate, where she continued some time.

No. 84.—A three-quarter-grown cat was put into a four-hundred-and-fifty-cubic-inch jar, with half a drachm of spirit of wine, and twelve minims of chloroform; temperature, 60°. She soon began to slaver; in two minutes, she was somewhat convulsed, then gradually became sleepy and quiet; in six minutes, she was asleep at the bottom of the jar; in ten minutes, she was nearly insensible; in fifteen minutes, quite so, and unconscious; and so continued until taken out at an hour and a-half. She was then much more depressed than No. 83. It was with the greatest difficulty the heart could be felt, and she could be thrown up to any height without making the slightest effort or motion. Muscular power gradually returned, though in half an hour she was still unable to move; but the flaccidity had disappeared, and reflex action had returned. The next morning she was quite well, though the heart was feeble and rapid in its action.

No. 85.—In order to ascertain the *post-mortem* appearances in an animal destroyed by chloric ether, a full-grown cat was placed in a four-hundred-and-fifty-cubic-inch jar, (temperature, 62°,) with a drachm and a-half of chloric ether. In ten minutes she was insensible, without any appearance of distress. The ether was renewed four or five times in quantities of half a drachm, put upon tow, and laid at the nose; the first two applications excited her, but not the last two. Respiration continued until fifty minutes; at sixty she was removed, and immediately examined. The pupils were widely dilated. Chest: lungs intensely crimson, and not so much collapsed as often seen, but by a little pressure became so; bronchial membrane quite white; no mucus; pulmonary veins full. Heart: both right cavities distended, as was the left auricle, but not the ventricle; no motion on either side; venæ cavæ distended; blood dark and alike on both sides; it soon coagulated in escaping, but did not very soon become bright. Abdominal viscera not much congested; liver very dark; bladder contained a little urine. Head: the sinuses of the dura mater, all the vessels of the pia-mater, and the entire substance of the brain much congested; a little effusion of serum in the ventricles.

HYDROCHLORIC ETHER.

MURIATIC ETHER—CHLORIDE OF ETHYLE.—(Comp. C_4H_5Cl. Boils at 52°. Sp. gr. at 40° 0.874.)

No. 86.—A three-quarter-grown cat was placed in a six-hundred-cubic-inch jar, with a drachm of hydrochloric ether. She began to slaver in one minute, gradually became dull, and in the course of five minutes lay as comfortably as possible at the bottom of the jar quietly asleep, being very nearly, but not absolutely, insensible. Taken out at thirty minutes, during the whole of which time she had been without moving, soundly asleep. When taken out she was insensible to all but the most severe pressure. She soon breathed more freely, and became conscious, then excited and cross, and in five minutes went staggering about the room like a drunken man; but in ten minutes was nearly well, except the heart beating very rapidly.

No. 87.—A full-grown cat was placed in the same jar, (temperature, 60°,) with a drachm of hydrochloric ether obtained from another chemist. As the only effect during fifteen minutes was to make her rather dull, she was taken out of the jar, and very quickly returned to it, (in order to renew the air,) with another drachm of the ether. She began to slaver copiously, then to be very sleepy, and with great difficulty could sit up; but beyond this, during the subsequent three-quarters of an hour, there was no effect produced. When released, she jumped off the table, but nearly fell in so doing.

No. 88.—A very large rabbit was similarly treated as the last cat, with exactly the same result, except that there was no flow of saliva.

No. 89.—An adult cat was placed in a six-hundred-cubic-inch jar, (temperature, 62°,) with two drachms of hydrochloric ether. A little sleepiness and a great flow of saliva only were induced. At half an hour, forty minims more were put in; this somewhat excited at first, and afterwards rendered it more sleepy, but there was no loss of consciousness or sensation; and when taken out, at the end of an hour, she was rather weak, but otherwise quite well.

HYDROIDIC ETHER.

Iodic Ether; Iodide of Ethyle.—(Comp. C_4H_5I. Sp. gr. at 70° 1.92. Boils at 160°.)

No. 90.—The same small dog (No. 99,) as had the Dutch oil forty-eight hours before, being quite well, was placed in the six-hundred-cubic-inch jar, (temperature, 57°,) with thirty minims of hydriodic ether, for the purpose of ascertaining how much would destroy it; the jar was not completely closed. He immediately became uneasy and struggled, but was not convulsed, nor were there any signs of irritation; in three minutes he had sunk to the bottom of the jar insensible; the breathing continued pretty regular during seventeen minutes; it then became irregular, with considerable stoppages, but did not altogether cease until thirty minutes.

Post-mortem examination in half an hour after respiration had ceased.—Body smelling very strongly of phosphorus, and on extinguishing the light, nearly all his surface was *strongly* phosphorescent; indeed, when rubbed, the flame became so strong that the hair was slightly singed in two or three places, and a perfect cloud of white vapour arose. This light was even faintly visible for an hour; it was confined to the skin, where the fluid came in contact with it. The muscles were all flaccid and pale. Chest: lungs quite crimson and collapsed, but rather solid; pulmonary veins much distended; all the cavities of the heart very full, the right auricle excessively distended, the appendix of this was the only portion which moved; venæ cavæ much distended, especially the descending vein; blood all fluid, rather dark in the vessels, on escaping, it became of a brick-red colour. Head: sinuses much distended, as were the vessels of the pia mater and of the substance of the brain; this was full of serum, of which there was also an effusion into the ventricles, but not upon the surface.

Forty-four hours after death.—The heart had somewhat shrunk in size, but all the cavities contained very soft black coagula, as did the large veins and the aorta. The lungs were shrunk, and had become dark and solid; the liver, where in contact with air, had become of a quite bright scarlet colour, as had the blood in the congested vessels of the pia mater.

No. 91.—A strong, full-grown, rough-haired dog, had given upon the large thin sponge, wrung dry out of water at 65°, thirty-five minims of hydriodic ether. It struggled much for one minute, but in two was insensible, though reflex action was not lost; at three minutes, all the ether being gone, he was let go. After a minute he became wild, and turned rapidly round a few times before he could stand; he then got up and ran staggeringly about the room, most violently rubbing his neck, and much excited, but quite sensible. The next day he was dull, very cross, and eat but little; on the following morning he was found dead and perfectly rigid.

Post-mortem examination forty-five hours after experiment, and from twenty to twenty-four after death.—Head: sinuses of dura mater congested, as were the vessels of the pia mater, with dark blood; substance of brain, vascular and serous, but firm. Chest: lungs collapsed, brown in colour, and full of reddish fluid blood; there was no apoplexy nor effusion of serum; the bronchial membranes congested. Heart: both left cavities were firmly contracted, but contained a little black blood; the right cavities were quite flaccid, and contained, as did the venæ cavæ, black treacly blood, with a good deal of air; the aorta contained some fluid black blood. On opening the abdomen there was an immense gush of black fluid blood, so that all the viscera were at once bathed with it; not less than half a pint escaped. As the chest was being opened the axillary vein was cut; I suspect the air entered here, and possibly forced the blood from the cavæ and right auricle through a wounded vein of the liver, which was full of blood; the abdomen was being opened at the same moment as the chest, which would favour such an occurrence.

No. 92.—A full-grown cat was placed in a six-hundred-cubic-inch jar, at a temperature of 57°, with thirty minims of hydroidic ether. It was immediately affected: it shook its head much, and turned about, as though the vapour were disagreeable, but there was no cough nor flow of saliva, no struggling nor convulsion; it became sleepy; in three minutes was at the bottom of the jar, and in four quite insensible. It was removed at thirty minutes, still perfectly insensible, not having stirred in the slightest degree since it became insensible; its breathing was quick, but regular, and tolerably powerful, and the heart beat with some force. It

lay insensible for six minutes, when it began to move, and gradually acquired sensation, but there was much indication of distress; it appeared very giddy, was purged, and vomited more than once; crawled a few steps, and then lay down. Though it improved, and was stronger, yet when put away for the night, after three hours and a half, it still appeared distressed. The next morning it was dead and perfectly rigid, so that it had been dead some time.

Post-mortem examination forty-five hours after the experiment, and from thirty-five to forty after death.—Head: vessels of dura mater rather congested; those of the pia mater more so; substance of brain firm and natural in appearance; no effusion. Chest: lungs nearly white in colour and collapsed, but in patches the air-cells had been ruptured. There was more blood in the lungs than the colour would indicate; it was red and fluid; the pulmonary veins not much distended; bronchial membrane white. Heart, small in size; the left cavities firmly contracted; the right quite flaccid, with some air in it; all the four cavities contained some blood, which was quite black and fluid, as was that in the venæ cavæ, which were not much distended; the upper of these vessels contained a good deal of air; the lower one did not. The liver was nearly black and full of blood; gall-bladder empty; none of the other abdominal viscera were congested. The muscles were all pale.

No. 93.—A very large male cat was placed in a four-gallon jar, with twenty minims of hydriodic ether; temperature, 65°. He made no resistance; in ten minutes he became dull and heavy, and so remained until the cover was removed, at the expiration of half an hour, when he got out, but appeared weak and very uncomfortable, though there was not any loss of consciousness. The phosphorescent light was very perceptible.

The next day he was exceeding dull, cross, and without appetite, and so continued for some time. He gradually became better, but it was several days ere he appeared as before the experiment.

HYDROBROMIC ETHER.

Bromic Ether; Bromide of Ethyle.—(Comp. C_4H_5B.)

Neither the specific gravity of the liquid or vapour, nor its boiling point, are given in chemical works. I find, however,

the fluid to be rather heavier than water, and the boiling point to be very little above 100°, not quite 105°.

No. 94.—A *very* small four-months'-old dog was put into a six-hundred-cubic-inch jar, at a temperature of 60°, with thirty minims of bromic ether. Within one minute he became affected and uneasy; at two he struggled a little and howled; in two minutes and a half he sank quietly to the bottom of the jar, quite insensible; he did not stir up to five minutes, when he was removed in a state of complete anæsthesia, the heart beating with tolerable power, and respiration pretty regular. In one minute reflex action had returned; in three he could move one limb; in five he was perfectly conscious, and pleased to be noticed, but could not stand; in seven minutes he got up and walked away, and soon was perfectly well. Before becoming insensible, and as he recovered, he made considerable grunting noise in breathing, but not when insensible.

No. 95.—A full-sized, young, mongrel terrier dog was put into a four-gallon jar, with one drachm of bromic ether; temperature, 65°. He was very little affected for nine minutes, when he howled, and very soon became insensible; he continued with the respiration very laborious, otherwise motionless, and in a condition of deep anæsthesia, as though he would die, for ten minutes, that is up to twenty after being put in the jar; when he gradually improved, and in another five minutes, (twenty-five,) on the cover of the jar being removed, the ether all being gone, he got out of the jar himself, and walked in a very unsteady manner to one corner of the room, where he lay down breathing quickly for a few minutes, but he was soon well again.

No. 96.—A small, but full-grown, cat was put into a six-hundred-cubic-inch jar, temperature 60°, with ten minims of bromic ether. For five minutes there was very little effect; she was then for five minutes rather restless, when she became sleepy, and sat quite upright, supporting herself against the side of the jar. After a few minutes this went off, and when released at thirty minutes, she was perfectly well, never having been insensible.

No. 97.—A larger cat than the last was placed in a six-hundred-cubic-inch jar, temperature 60°, with twenty minims of bromic ether. Up to five minutes he sat perfectly still, with saliva flowing freely, when he howled, and became very nearly, though not perhaps absolutely, insensible; this in part passed off, though he

did not move until thirty minutes, when the cover being removed, he immediately got up and jumped off the table, rather weak, but otherwise well. A very large quantity of saliva had flowed.

No. 98.—A large male cat was put into a six-hundred-cubic-inch jar, temperature 64°, with one drachm of bromic ether. He absolutely did not move a muscle, but gradually sank down, head foremost, to the bottom of the jar, and in one minute he was perfectly insensible. The respiration became laborious, then slower, until fifteen minutes, when it altogether ceased. In twenty-five minutes he was removed from the jar, which still was very strong of the ether.

Post-mortem examination immediately.—Muscles quite flaccid. On dividing the phrenic nerves, the diaphragm slightly moved. Chest: lungs crimson in colour, and much collapsed; pulmonary veins very full; bronchial membranes pale and dry: heart, both auricle and ventricle on the right side as full as possible; the venæ cavæ also excessively distended; the left auricle also was very much distended, but the ventricle was firmly contracted and empty; the proper vessels of the heart were not much filled; the blood was alike dark on both sides. Head: sinuses filled; the pia mater congested, as was the brain, but not in a corresponding degree; its substance was serous, and there was a little fluid in the ventricles and upon the surface.

Twenty-four hours afterwards.—Muscles very rigid. The left ventricle of the heart quite hard, and so firmly contracted as not to leave any cavity; not a drop of blood in it. In both the auricles the blood was perfectly fluid; in the right ventricle there was the faintest coagulum; all the blood in the veins was fluid, and all black. The lungs in colour had become like liver.

DUTCH OIL.

Chloride of Olefiant Gas—Oil of Olefiant Gas; Hydrochlorate of Chloride of Acetyle—Dutch Liquid.—(Comp. $C_4H_4Cl_2$. Heavier than water. Boils at 180°. Sp. gr. of vapour, 3.4484.)

No. 99.—A four-months'-old hound dog, in most miserable condition, having been nearly starved, had given, by means of a sponge, thirty minims of chloride of olefiant gas; temperature, 70°.

He did not make any resistance, but inspired fully and deeply, as though it were pleasant. In three minutes he was perfectly insensible, with the pupils widely dilated; at five minutes, all the liquid having disappeared, he was put down; he continued motionless and senseless for three minutes, with the heart, however, beating with pretty good power, and respiration going on; he now rallied; at four minutes he could crawl, and at six walk pretty well; at ten he appeared well, and so continued.

No. 100.—A large, full-grown, Isle of Skye dog had forty minims of chloride of olefiant gas given upon a sponge, at 70°. He struggled a little against it, but was evidently affected in one minute, and insensible at two; at three, all the liquid being gone, he was laid down, unconscious. Almost immediately he rallied, looked wild and excited, rolling over and over before he could stand; in six minutes, he appeared as well as ever. The lips were made rather sore by the fluid.

No. 101.—A three-quarter-grown cat was placed in a five-hundred-cubic-inch jar, at a temperature of 60°, with thirty minims of Dutch oil. It remained unaffected for a minute, when saliva began to flow; it gradually became sleepy, without any indication of uneasiness, and in three minutes was fast asleep at the bottom of the jar. It was removed at five minutes, perfectly senseless, and without reflex action; the heart could just be felt beating. There was soon a little motion in the lips, which increased into respiration; it lay otherwise motionless, as though dead, but gradually acquired a little power. In eight minutes it vomited a mass of curdled milk, which it soon partially eat again; in ten minutes it could raise its head, in twelve crawl about, and in fifteen it was quite well. There was not the least indication of suffering in any part of the experiment. As there was still remaining a strong odour of the liquor in the jar, another young cat was put in. She hardly stirred, but did not fall asleep until a quarter of an hour, and did not lose consciousness, and appeared to enjoy the odour rather than not.

No. 102.—A full-grown young cat was put into a six-hundred-cubic-inch jar, (temperature, 60°,) with a drachm of Dutch liquid. She soon began to slaver, gradually falling asleep, without any distress. At three minutes, she was soundly asleep, unable to

sit, breathing quickly; in five minutes, there was neither unconsciousness nor sensation. She was kept in until ten minutes, not having perceptibly respired for two minutes. The only indication of life was some little motion of the heart. Power and sensibility gradually returned. In ten minutes after being taken out, she was just able to crawl, and perfectly happy; in fifteen minutes, quite well. She was purged now.

No. 103.—A very large rabbit was put into a similar sized jar, with one drachm of the liquid. It was longer in being affected, and showed some little sign of being uneasy; but in five minutes was asleep, and in seven quite insensible, with the respiration very rapid. It was kept in the jar fifteen minutes, being perfectly insensible when taken out, but having reflex action. It continued longer motionless than the cats. It was eight minutes before it could at all move; in ten it tried to crawl, which in fifteen it could do, though in half an hour it was still quiet and dull.

No. 104.—A three-quarter-grown cat was put into a six-hundred-cubic-inch jar, (temperature, 65°,) with forty minims of Dutch oil. It immediately showed symptoms of feeling the effect, and in three minutes was insensible at the bottom of the jar. It continued absolutely without any motion, except the faintest motion of the ribs, until twenty minutes, when the respiration was rather more evident. It was now taken out in as complete a condition of anæsthesia as I ever saw an animal. It remained so during ten minutes, when it began to improve, and at the end of twenty minutes after being taken out, it could just walk; in half an hour it appeared well. There was not any distress; and there was not so much muscular weakness nor depression as after chloroform.

No. 105.—A three-quarter-grown cat was placed in a five-hundred-cubic-inch jar, with twenty minims of the chloride of olefiant gas. It remained unaffected for nearly eight minutes, then gradually fell asleep; in twenty minutes it was perfectly insensible, but continued to breathe regularly and with vigour during the entire time it was kept in. On the jar being removed, it lay as though comfortably asleep, soon moved as though stretching itself, and gradually roused up; but it was a quarter of an hour before it was fully awake. It appeared to feel so comfortable as to wish to remain in this condition.

No. 106.—A very large old male cat was placed in a four-gallon jar, with thirty minims of chloride of olefiant gas, at a temperature of 55°. For five minutes there was little effect, when he became dull and sleepy, gradually sinking to the bottom of the jar. In ten minutes he was altogether insensible, with the breathing rather stertorous; he was allowed to remain in three-quarters of an hour, during which time he did not stir, when the liquid being exhausted, he was taken out. Sensation was wholly destroyed, but not motion; he gradually improved, though complete consciousness and power of walking were not established until the lapse of a quarter of an hour. Next morning he was quite well.

No. 107.—A cat, corresponding in size with the last, was put into the same jar, with ten minims of the oil, (temperature, 65°,) and allowed to remain in three-quarters of an hour, when the cover was removed. He was not asleep, but lying quite still and happy; indeed he would not get out, though perfectly able to do so. The fluid was all exhausted.

No. 108.—A full-grown cat was placed in a six-hundred-cubic-inch jar, (temperature, 62°,) with eighty minims of chloride of olefiant gas. It was not affected quite so soon as the others; but in eight minutes it was insensible. Successive portions were added, being placed over the mouth and nose upon pieces of paper until three drachms were used. It was taken out at an hour and a-half, not having breathed for the last six minutes; and when it did, only very feebly, so as to render it difficult at times, for the last quarter of an hour, to say if it did breathe. The first addition of the liquid excited it, but it was unconscious of the others. The pupils were intensely dilated. It did not give any sign of uneasiness during the whole time, and the condition of the anæsthesia was most intense.

Post-mortem examination immediately.—Chest: lungs crimson in colour, but not very intense; much collapsed; bronchial membrane quite white; no mucus; pulmonary veins moderately full. Heart: all the cavities alike moderately full; both auricles rapidly contracted, the ventricles very slightly moved; venæ cavæ moderately full; the blood at first dark, but on exposure, soon became red, and that in the pulmonary veins more so than that in the venæ cavæ. No effusion in the chest. Head: sinuses of dura mater

not congested, vessels of the pia-mater rather so, the substance of brain not at all; no effusion. The liver was of a bright colour; the bladder *very* full of urine. The blood soon coagulated.

No. 109.—A three-quarter-grown cat was placed in a five-hundred-cubic-inch jar, with thirty minims of the oil. She became affected directly, soon fell asleep, and was insensible. I was called away, and detained three-quarters of an hour; on my return she was dead, apparently, from her position, not having stirred.

Post-mortem examination in half an hour.—Chest: lungs rather pale, and much collapsed; pulmonary veins rather, but not excessively, full; bronchial membrane slightly congested, no mucus upon it; no motion in the heart; left ventricle firmly contracted and empty; auricle full; both right cavities distended; venæ cavæ full; blood all fluid, and not very dark, that on the right side most so, it soon coagulated. Abdominal viscera somewhat congested; bladder and intestines very full. Head: sinuses, vessels of pia-mater, and substance of brain, all congested; blood not very dark; brain serous.

No. 110.—A moderate-sized Prussian carp (*Cyprinus Gibelio,*) was placed in a dry sixty-cubic-inch jar, (temperature, 60°,) with five minims of chloride of olefiant gas, and allowed to remain in during an hour. For the first forty minutes it continued to breathe freely, and every few minutes to move actively; after which, though by no means still, its motions were less active. When taken into the hand, it moved actively; and on being put into water, it swam about freely as before the experiment. It remained well.

No. 111.—A carp, of the same size, was placed in a corresponding jar, with ten minims of the liquid, and also allowed to remain in an hour. Up to forty minutes, except moving when touched, it lay very still, and with the gills, for the most part, closed; at this time, it moved and leapt about the jar with considerable vigour, after which it was perfectly still; but on being taken out, it moved the gills and tail *very* slightly; its skin was covered with mucus. On being put into water, it slowly and rather unsteadily moved away, but after two minutes it appeared nearly well again, and so remained (apparently perfectly well,) for several hours; but during the next day it appeared dull, this

increased, it lost the power of balancing itself, the body was rigid, with the skin rough and dry, and it moved but little. The following morning, forty-fours after the experiment, it was dead.

No. 112.—A carp, of the same size, was placed in a jar with twenty-four ounces of water, containing ten minims of the liquid; temperature, 60°. It was very quiet in the water for nearly an hour, when it began to swim very slowly backwards, and to move the pectoral fins quickly for another hour, not perceiving any object, unless touched rather smartly with it; after which it dashed more actively about the water, evidently not seeing, and with its head often out of the water, then rolling over and over, gradually becoming quieter, and sinking to the bottom of the jar, where, at three hours and a half, it had been lying motionless, except laboriously breathing, for a quarter of an hour. On being put into pure water, it soon rallied, and the next day was as well as ever, and so remained.

Having ascertained the quick and pleasant manner in which animals pass into a complete state of anæsthesia from a small quantity of the Dutch oil, and that in no case was there any irritation, I inhaled a few minims myself—not sufficient to lose all consciousness, but to enable me to judge of its effects. These I found in every way agreeable. I now gave it seven times to some medical students. One of them inhaled it three times, one twice, and two once each. In no case were more than thirty minims given, at first, upon a thin cloth; and in four, twenty minims more were given. Six out of the seven times, perfect insensibility was produced; the other gentleman was made most happy, declaring the seventh heaven was nothing; he was in the ninth—nay, in the eleventh; hoped he might never come out, and so on.

I now gave it to a parturient woman, in an extremely delicate and feeble condition, legs excessively œdematous, and I have no doubt with diseased lungs, who had been in strong labour for three hours with hardly any progress, from a rigid os uteri. Twenty minims were given, and twice ten in a quarter of an hour. The child, a small one, was born: the change in the os uteri was marvellous. She was not altogether insensible.

Thursday, March 8th.—At three operations at the Leeds General Infirmary, it was given—To a man, aged fifty-five, who

had had for some years contraction of the adductor muscles in both thighs, in which the legs were forcibly abducted while under the influence of this fluid. At first forty minims were given, and the effect kept up by twenty given twice afterwards; in all, eighty minims. The muscles were fully relaxed, and the thighs were much separated. A woman, aged forty-two, had forty minims at once; a small malignant tumour was removed from the side. A boy, aged fifteen, had the outer hamstring muscle of *both* legs divided; in all, he had eighty minims, forty at first, and twice twenty. The operation necessarily occupied some time. He was unconscious, even after removal to bed. All did well.

March 17*th*.—Through the politeness of my friends, Messrs. Smith, Hey, and Teale, the Dutch oil has again to-day been given in four operations, (two young women and two men,) with success.

OLEUM ÆTHEREUM.—(*London Pharm.*)

Oil of Wine.

"According to Mr. Hennell this is a sulphate of hydrocarbon. Dumas calls it sulphatic ether; others a double sulphate of ether and hydrocarbon; while Liebig terms it ethereo-sulphate of ether-oil, the ether-oil being applied by this writer to a fluid $\frac{4}{4}$ths carbo-hydrogen."—*Pereira*. Composition, according to Mr. Hennell, carbon 9, hydrogen 9, sulphuric acid 1 = 1 of ethereal oil; according to Liebig and Serullas, carbon 8, hydrogen 8, sulphuric acid 2, water 1. Sp. gr., according to Mr. Hennell, 1.05; to Serullas, 1.13. But I find in two specimens which I used, and which were obtained as pure articles from Howard and Co., who as manufacturing chemists stand very high, it is rather lighter than distilled water, consequently must be of less specific gravity than that stated by either of these gentlemen. Also another specimen, which I procured from Gale, Baker, and Co., was lighter than distilled water, but a trifle heavier than Howard's: it was without any yellow tinge, not of so ethereal an odour, nor so aromatic as it, and will be seen not possessed of equal anæsthetic power. This, I suspect, arises from the fact of the preparation not being an uniform or constant one, but containing, according to circumstances, a varying quantity of oxide of ethyle.

No. 113.—A terrier dog was put into a two-thousand-cubic-inch jar, with two drachms of oleum æthereum, at a temperature of 65°. The cover was removed in thirty-five minutes; he jumped out of the jar, and employed himself in vigorously rubbing his neck upon the matting covering the floor. The heart beat rapidly, otherwise not affected.

No. 114.—I gave to a full-grown, but not very large, spaniel, by means of a large thin sponge held over the muzzle, one drachm of oleum æthereum; temperature, 68°, Fahr. The dog was rendered dull and sluggish, but not insensible.

No. 115.—A strong, two-months'-old, bulldog pup was put into a three-hundred-and-seventy-five-inch jar, with forty minims of oleum æthereum. It struggled to escape for one minute, then sat easily and quietly, as though falling asleep, for five minutes, when it roused up; and at ten minutes, the oleum æthereum being nearly exhausted, it was taken out in almost a natural state.

No. 116.—A nearly half-grown cat was placed in a six-hundred-cubic-inch jar, with forty minims of oleum æthereum; temperature, 65°. At the moment it was put in it was eagerly devouring a piece of meat, which it immediately dropped. In three minutes it began to be restless, and continued to make half-conscious and half-convulsive attempts to escape, until ten minutes, when it fell quietly asleep at the bottom of the jar; but soon again roused up into the same condition. Removed in twenty minutes, very weak and unable to walk, but quite conscious and able to sit.

No. 117.—A full-grown cat was put into a six-hundred-cubic-inch jar, with a drachm and a-half of oleum æthereum. She immediately began to moan, which she continued for a minute, then was still until five minutes; she became rather uneasy until eight minutes, when she was quietly asleep, and she continued so, with very little interruption, for half an hour. When she was taken out of the jar, she immediately woke up, but was unable to stand at first, but soon staggered and rolled about the room. In half an hour, she appeared nearly recovered.

No. 118.—A very large and powerful old male cat was put into a jar not much larger than would contain him, with a drachm of oleum æthereum, and covered over. It was very late at night,

and only one candle left burning, he being brought just as I was retiring to bed. As the light was not very good, in three minutes the cover was removed, and the candle brought near to ascertain the effects; he was seen to be crouched down, soundly asleep; but inadvertently in examining, the candle was brought too near, the vapour became inflamed, and in an instant the whole jar was in a fearful blaze, the cat being completely enveloped in it. The only means to extinguish it was to exclude the air by putting on the cover; this was done, and the flame very soon out, when the cat was still soundly asleep, not having stirred, being altogether unconscious of the fire. The hair was much singed, and the nose, mouth, and eyelids blistered, but he was not otherwise injured. The next morning, except this, he was as well as ever.

No. 119.—A cat, very nearly full-grown, was placed in a six-hundred-cubic-inch jar, (temperature, 60°,) with a drachm of the oleum æthereum, from Gale and Co. As no effect was produced in twenty minutes, one drachm more was put in; this also produced very little effect for a quarter of an hour, after which she became very sleepy, but did not lose sensation or consciousness: she had great difficulty in keeping up. At the expiration of an hour, when she was removed, this had in a great degree subsided, and she jumped off the table, but fell on reaching the ground.

No. 120.—A very large old rabbit was put into a similar jar, with forty minims of the same ethereal oil. It became rather sleepy. At twenty minutes, forty minims more were put in, with hardly any effect; at the end of an hour, on being removed, it was quiet, but quite able to walk about.

No. 121.—A month-old rabbit was placed in a gallon jar, with fifteen minims of oleum æthereum; temperature, 68°. It gradually became sleepy, without any uneasiness, but did not completely fall asleep up to twenty minutes, when it became more wakeful, and at half an hour, when taken out, it was as lively and active as ever.

No. 122.—A rabbit of the same age as the last was put into a similar jar, with twenty minims of oleum æthereum; not much affected until three minutes, when it tried to escape, and became unsteady. At five minutes it sat the very picture of an animal overcome by sleep, but was easily startled by a noise, and was

not insensible. It was allowed to remain in the jar for twenty minutes, at which time it had in part recovered from its sleepiness, and was not indisposed to move.

No. 123.—Another rabbit of the same age was put into a similar jar, with a like dose of oil of wine. It sat perfectly still, and soon fell fast asleep. On being touched, it rolled upon the side, without making any effort. It did not altogether lose sensation, and was easily roused. At twenty minutes it was not so much affected as it was at ten.

No. 124.—A sparrow was put into a ninety-cubic-inch jar, with three minims of oleum æthereum; temperature, 66°, Fahr. For five minutes no effect, except the respiration being rather quicker, was noticed. At ten minutes the bird had become dull, and on being taken out, it could not fly more than two or three feet at once, and had lost all fear, not in the least shunning being handled. It was returned to the jar, with six minims more of the oleum vini. It was now immediately affected, breathed very quickly, soon staggered as though drunk, fell, and had great difficulty in getting up again, which increased until five minutes, when it was taken out, not able to fly, but with power to move its legs and wings, quite sensible, but very dull and sleepy. On being returned to the jar it improved, was soon quite active and lively; on being taken out, it could hop about, and fly for several yards. It continued permanently well.

No. 125.—Another sparrow was put into a similar jar, with five minims of oleum æthereum. In one minute it began to stagger, then squatted down upon its haunches, perfectly still. On being touched, it fell over upon its side in a sound sleep, without making the least effort to save itself. After lying without moving for six minutes, it was taken out quite insensible. It was thrown up into the air nearly to the top of the room, but fell into the hand without being in any way roused. On this being repeated, it moved the wings a little, but relapsed into a motionless state for a minute, when it woke up suddenly, and in five more could fly two or three feet; and though not able to set itself upon the perch, when put on, it could sit; it immediately put its head under the wing, and continued soundly asleep for some hours. The next morning it was very dull, would not eat, and during the day died.

No. 126.—A full-grown frog was put into a thirty-eight-cubic-inch jar, with five minims of oleum æthereum, and kept in for five minutes. When taken out, it was still breathing, but was very flaccid, and nearly motionless, though not absolutely unconscious, in which condition it remained for nearly a quarter of an hour; it then gradually improved, and in three-quarters of an hour could jump vigorously about as well as ever.

No. 127.—A moderate-sized frog was put into a jar holding thirty-eight cubic inches, with ten minims of oleum æthereum. At first it leapt violently, but in half a minute became still; and after one minute, did not stir. It was taken out at three minutes, perfectly flaccid and motionless. Three of the limbs were amputated in successive portions, without it showing the least indication of feeling, or indeed of life. After a few minutes, the heart was perceived to pulsate at long intervals; it then began to breathe, but it lay perfectly helpless upon its back for an hour and a half, when being called out, I left the room. On my return, in half an hour, I found it had jumped off the table, and was making its way about the room with the one remaining hind leg quite vigorously.

No. 128.—A similar sized frog was placed in a jar of the same size, with twenty minims of oleum æthereum. It continued to move rather longer than the last, but in other respects was similarly affected, and the limbs were in like manner cut off. After lying an hour and a half, the body was cut open, without any indication of pain. The heart was in motion, but it was evidently not propelling any blood; the apex was tilted forwards, but there was nothing like any systolic or diastolic action; in fact, the ventricle was empty and contracted, the auricles being moderately full.

No. 129.—A like sized frog was put into a similar jar, with thirty minims of oleum æthereum. It continued to move rather longer than No. 127, but not so long as No. 128; in all other respects, it was similarly affected and treated as to amputation. After an hour and a half, in which there was not any indication of life, it was cut open. The left auricle contained some blood, but the right auricle and the ventricle were empty. On being touched, the former contracted, but no motion was perceived in the latter.

No. 130.—Two small Prussian carp (*Cyprinus Gibelio,*) were placed in dry thirty-cubic-inch jars, the one with ten minims of oleum æthereum, the other in a jar with fifteen minims, and allowed to remain fifteen minutes. Both continued at intervals to breathe; that in the ten minims lay comparatively still, but the one in fifteen was convulsively moved two or three times. On being put into water, they did not appear at all the worse, the only effect being a considerable effusion of mucus.

No. 131.—A larger carp was put into a jar containing thirty-two ounces of water, with ten minims of oleum æthereum, (temperature, 60°,) and allowed to remain in for one hour and three-quarters, the only effect being, perhaps, a disposition to swim backwards. Forty minims more were now added: little effect was at first produced, but after some hours it became very dull, rolled upon the back and side, then swam about again, gradually becoming weaker until, at the expiration of thirty hours, it had lain so long motionless upon its side, that I thought it quite dead, and accordingly removed it for the purpose of throwing it away; but as I had it in my hand examining if it could be made to feel, and opening the operculum two or three times, I fancied there was a slight effort at respiration, and put it into pure water, when it gradually revived, and after ten hours, it was perfectly natural again.

This experiment was repeated upon a similar sized carp. At the expiration of the thirty hours, it was not nearly so much affected as the preceding one, and it was accordingly kept in for forty-eight hours, at which time it was even capable of feebly moving, but on being placed in pure water, it did not show any appearance of rallying, and soon died.

No. 132.—A *Blatta orientalis* was put into an ounce jar, with two minims of oleum æthereum. It almost immediately fell struggling, but in two minutes it was nearly motionless, and in four appeared to be dead; but on being taken out it gradually recovered, and in an hour could crawl actively about.

A second cockroach was put into a like jar, with four minims. It was affected in precisely the same way, but was kept in six minutes; in half an hour it was nearly well again.

A third cockroach was treated with eight minims of the oil of wine. It also was similarly affected, but did not recover.

A *Blatta lethifera* was also put into an ounce jar, with four minims of oil of wine. It was similarly affected; in half an hour it appeared to be recovering, but soon after died.

No. 133.—Three slugs (*Limax ater,*) were put into three four-ounce jars, with two, four, and eight minims of oleum æthereum. They were each kept in the jars for eight minutes; at first they rolled about as though in pain, became covered with a coating of mucus, motionless, and insensible, especially the last, shrunk in size, and very soft. In twenty minutes they all showed signs of feeling, on being pricked, by the mantle and cloak moving, and in a short time could crawl a little. They were put into a jar for the night, and on the following morning the two first were perfectly well, but the third was dead.

A similar experiment was made upon three snails (*Helix nemoralis,*) which were allowed to remain in ten minutes, as they had shrunk into the shells, and consequently were not so much exposed to the vapour. They all recovered.

No. 134.—A full drop was allowed to fall into the respiratory orifice of a large slug. A great quantity of mucus was effused; it became motionless and insensible, but the next morning it was perfectly well, eating as the others.

HEAVY OIL OF WINE.

Sulphate of Oxide of Ethyle and Etherole—Sulphovinate of Etherole.—(Comp. $C_8H_9O, 2SO_3$.)

As this is a preparation not easily to be obtained, I applied to Mr. Morson, of London, to prepare me sufficient for trial. It is thus described in the last edition of Turner, by Liebig and Gregory:—"It is a colourless, oily liquid, heavier than water; specific gravity, 1.133, of an aromatic ethereal odour, and a cooling taste, without action on dry vegetable colours; it boils at 540°." That which I received had an aromatic, somewhat ethereal, odour, and thick oily consistence; was of a dark brown colour, of strong acid reaction, as shown by the quantity of carbonate of soda it decomposed, and of an acid, irritating taste; indeed, it produced, when applied in very small quantities to the tongue, considerable

pain, as if from its acidity. I stated this discrepancy to Mr. Morson, who replied,—"Heavy oil of wine, although light coloured when first obtained, changes rapidly, and is a most uncertain and indefinite preparation, and cannot be profitably employed,—at least, such is my opinion;" one in which I coincide, from its effects upon animals.

No. 135.—A large, full-grown cat, was placed in a six-hundred-inch jar, with ten minims of the heavy oil of wine; temperature, 68°. It was kept in for twenty minutes, no effect being produced.

No. 136.—A cat, not quite half-grown, was placed in a similar sized jar, with twenty minims of heavy oil of wine; temperature, 68°. It was kept in during three-quarters of an hour, no decided effect being produced. When let out, it immediately began to contend with other animals for food.

No. 137.—A three-quarter-grown cat was put into a six-hundred-cubic-inch jar, with thirty minims of the heavy oil of wine; temperature, 74°. At twenty-three minutes became very restless and uncomfortable, but neither lost consciousness nor sensibility; half a drachm more was put in, which distressed it a good deal, and it made more than once very violent attempts to escape, its breathing being very much oppressed, without any loss of consciousness or sensation, and only appearing rather sleepy. At fifty minutes it was removed, the saliva had flowed very freely; it immediately set to work to clean itself.

ALDEHYDE.

As the hypothetical base of aldehyde only differs from ethyle in containing a less proportion of hydrogen, its formula being C_4H_3, and aldehyde possessing many of the properties of the ether compounds, it appeared desirable to try it. It is supposed to be a hydrate of the oxide of acetyle, its formula being $C_4H_3O + Aq$. It is a colourless, clear, thin liquid, has a peculiar, somewhat aromatic, smell, and the vapour is very irritating and suffocating. It boils at 72°; specific gravity at 65° 0.79.

No. 138.—A cat, one-third grown, was put into a jar holding two hundred and forty cubic inches, with five minims of aldehyde. She *instantly* turned round and round, and made violent attempts

to escape: in one minute she became quiet and sat still, with saliva dribbling freely from the mouth, the eyes being irritated and watery. She did not fall asleep, and gradually improved. She was taken out at ten minutes, sleepy and dull, but not otherwise the worse. She could run, and set to work to lick herself clean, being wet from the saliva. She was almost immediately perfectly well.

No. 139.—A strong, young hound dog, about three months old, was put into a jar holding three hundred and seventy-five cubic inches, with ten minims of aldehyde. He also instantly became affected, and made most violent attempts to escape. After three minutes, he lay breathing laboriously, heavily and slowly, but was restless. Taken out at ten minutes, dull, but quite sensible, and pleased to be noticed. He was soon perfectly well, not having lost consciousness.

No. 140.—Another dog, of the same size and age, was put into the same jar, with twenty minims of aldehyde. He also struggled most violently to escape, but in forty-five seconds he became quiet, sitting, breathing most laboriously, until six minutes, when for one minute he roused up; afterwards he sank into the same quiet state, being occasionally restless and uneasy, until ten minutes, when the cover of the jar being removed, he immediately put his head out of it, the only effect being a little hoarseness, with dryness of the mouth and fauces.

No. 141.—A kitten was put into a two-hundred-and-forty-cubic-inch jar, with ten minims of aldehyde. It, as the others, instantly made desperate efforts to escape for a minute, then became nearly still, with the saliva running freely; it so remained until five minutes, when again it tried very hard to escape; afterwards it was almost still, until ten minutes, when the violent efforts to escape were renewed. At twelve minutes, on the cover being removed, it immediately got out of the jar, with plenty of strength. It coughed somewhat, but appeared in no other respect the worse.

No. 142.—A kitten, one-third grown, was put into a two-hundred-and-forty-inch jar, with twenty minims of aldehyde. It struggled to escape with the *greatest* violence for nearly three minutes; it then lay still, breathing slowly and laboriously until ten minutes, when it was taken out perfectly insensible, motionless,

and without reflex action. After ten minutes, reflex action had returned; there was some little power of moving, and sensation was returning; respiration was most hurried. It shortly could mew, its senses were restored, and it was able to crawl. Both, while in the jar and afterwards, the fæces were freely passed. The next morning it was perfectly well.

No. 143.—An old male cat was put into a three-hundred-and-seventy-five-inch jar, with thirty minims of aldehyde. He did not make, as most of the others, the same violent efforts to escape, but sat still, slavering, with occasional struggles, and trying as much as possible to resist breathing, until seven minutes, when he became intensely, but unconsciously, convulsed for a minute, and afterwards insensible, occasionally moving, but for the most part perfectly still, slowly breathing. The cover was removed at fifteen minutes; taken out quite motionless, and as insensible as a stone. From a wound in the ear, the blood which flowed was perfectly florid; the mouth and fauces were very red; he almost immediately began to pant and to breathe very quickly. In five minutes he tried to mew. The heart was now beating very rapidly and feebly, but most tumultuously, and with much noise; sensation was returning, as well as motion. At seven minutes he was able to cry, and at ten he had so far recovered muscular power, as to be able to run. He continued for some time to slaver, but perfectly recovered, otherwise, in a short time.

No. 144.—A young cat, three-fourths gone with kitten, was put into a three-hundred-and-seventy-five-inch jar, with thirty minims of aldehyde. For two minutes she struggled very hard to escape; she then lay still, with occasional moving, slavering, and breathing slowly. At fifteen minutes she was removed from the jar, but she had been dead for at least three minutes.

The body was immediately opened.—There was vermicular motion of the uterus, but not a single fœtus stirred in the least, though the *umbilical arteries pulsated.* The lungs were nearly of a natural appearance. The heart was of moderate size, and its own proper vessels not congested; the right auricle was distended with dark blood, the right ventricle contained but little; the left ventricle was contracted and empty, the left auricle contained dark blood; the aorta was empty, but the pulmonary artery was

full, and the pulmonary veins as well; the venæ cavæ were moderately full. The intestines, like the uterus, showed vermicular motions.

No. 145.—A three-quarter-grown cat was placed in a six-hundred-cubic-inch jar, with fifty minims of aldehyde. It directly made great attempts to escape, but was not convulsed. In five minutes it was insensible, and lay breathing very slowly, but *very* deeply, until taken out at five minutes, altogether motionless, the fæces having escaped. It soon breathed more quickly, in five minutes could move, in ten was sensible, and in fifteen could walk, and was very desirous to be noticed. It was very weak, and the heart could scarcely be felt. The aldehyde in this experiment had been kept for some time, and I think a little acetic acid had formed.

MIXED SUBSTANCES.

It having been thought by some that chloroform and ether, if given mixed, would prove more manageable and safer, at the same time equally effectual, than either alone, the following experiments were tried. Others, as Nos. 49, 71, and 77, may also be referred to, where two of the substances were given mixed, or one soon after the other. In the latter case, it was rather for the purpose of contrasting the different effects of the two agents; in the former, the effect was not sufficiently marked to show that the combination possessed any particular advantage over the agents singly.

No. 146.—A very strong, but small, young dog, was put under a six-hundred-cubic-inch cover, with half a drachm of chloroform and half a drachm of oleum æthereum, portions of tow being saturated with the fluids; temperature, 65°. Fahr. He immediately laid down, and did not at any time make the least attempt to rise; he seemed uncomfortable, moving the head about; he breathed hard, with a snoring noise, was evidently sleepy, but appeared weak, though quite sensible. This continued for eight minutes, when he howled in precisely the same manner as those animals who are under the influence of a poisonous dose of hydrocyanic acid. This howling was prolonged for three minutes,

the noise, however, gradually becoming weaker, and sensibility less. During this time there was some convulsive movement, and the hind foot was retained in the mouth, as though he were all the time violently biting it, the jaws being rigidly closed. He was lying in a curled-up position, with his foot near the mouth, and probably he seized it as he would have done anything else, not knowing what it was. He now, at eleven minutes, became still and insensible, the eyes open and breathing hard, with much blowing noise, the tongue being often protruded. There was no indication of sensation, on being pinched sharply. At the expiration of thirty minutes he was taken out, having for the last seven minutes been more restless, and not quite so fully under the influence of the agents as before, though still asleep and insensible; he lay so for two minutes, then became somewhat convulsed, which soon passed into half conscious struggling. At four minutes he got up, and at six was walking about, in a staggering manner; in a short time he appeared to be perfectly well. The chloroform and oleum æthereum were not exhausted; he had lain upon the tow, and thus, to some extent, prevented evaporation. Neither the fæces nor urine were passed.

No. 147.—A dog, of the same size and age as No. 146, was placed under the same cover, with half a drachm of chloroform and one drachm of sulphuric ether, put in the same manner as in the last experiment, upon tow. He made some, but by no means violent, attempts to escape, then lay quietly down and fell asleep, breathing quickly, without any howling. Taken out at the end of half an hour. He had lain for a quarter of an hour without the least motion, and with the most perfect loss of muscular power, only breathing very feebly. When removed, the chloroform and ether were quite exhausted. For two or three minutes after being taken out, he lay perfectly still and senseless, then rolled about, as though attempting to rise, for seven minutes, when he got upon his legs, but was very restless, and as though intoxicated, moving about constantly, wandering round and round the room, and not taking the least notice when spoken to, even though sharply. He quite recovered, but not in so short a time as the last dog.

No. 148.—To a large and strong setter, one drachm of chloroform was given on a sponge dipped in water, at a temperature of 100°.

He was a very long-nosed dog, and the sponge was not quite large enough to cover it. Struggled hard for one minute, then became comparatively quiet, but never lost sensibility, and he continued to breathe deeply. The sponge was removed at five minutes, the whole of the chloroform being exhausted, when he immediately began to bark very loud and to rub his mouth, but was perfectly sensible, though weak. At twenty minutes after, the dog being perfectly well again, one drachm of acetic ether was given on the sponge, at a temperature of 80°. He struggled hard for one minute and a-half, then became quiet, and breathed deeply; he was now perfectly insensible, on being pricked in various parts, but on being released in five minutes, walked away as if nothing was the matter; looked sleepy, and immediately laid down, and drank some water with pleasure. In five minutes more retched several times, but did not vomit, breathed badly, and again became insensible, taking no notice on being pricked with the point of a scalpel, or of heavy pressure on the feet; he was very sleepy for more than half an hour, when he suddenly and rapidly recovered, got up and walked away, with sensibility quite restored.

No. 149.—A small, but strong, active bull-terrier, had given one drachm of acetic ether on a sponge, at a temperature of 90°. He struggled hard for one minute and a quarter, then became quiet, and continued to breathe slowly; at two minutes and a-half he was insensible, on being pricked in various parts of the body. The sponge was removed at five minutes, still smelling a little of the ether. When released, the dog ran off apparently none the worse. Seventeen minutes after, one drachm of chloroform on sponge, at 60°, was given. He struggled for half a minute, but in one minute and a-half became insensible; at three minutes, ceased to breathe and the heart to pulsate; four minutes, sponge removed. He lay for a minute without any appearance of life, when a quart of cold water was suddenly dashed upon the head; he immediately began to breathe, but this becoming very feeble, in five minutes more another quart of water was suddenly dashed upon the face and head, when he immediately shook his head; five minutes more, douche repeated, which made him howl and struggle to get away; after which he gradually improved and began to walk, though he was sensible some

time before he could walk. He seemed happy, but very weak, when left for the night. Next morning he was quite well.

Other experiments have been made with the agents mixed together, or in immediate succession. Reference to the numbers of these will be made in the remarks further on, under the head of "Mixed Substances."

IODOFORM—PERIODIDE OF FORMYLE.

(Comp. $C_2H\,I_3$ = Fo. I_3.)

No. 150.—A half-grown cat had two grains of iodoform put into the mouth, without any effect whatever being produced; not even any irritation of the mouth.

No. 151.—A large male cat was put into a six-hundred-cubic-inch jar, with two grains of iodoform, (temperature, 64°,) and allowed to remain during twenty minutes, no effect whatever being produced.

No. 152.—A strong, lively dog, was placed in a large jar, with five grains of iodoform, with just sufficient sulphuric ether to partially dissolve it; temperature, 68°. On the cover being removed, at the end of half an hour, he immediately leapt out, quite vigorous, and somewhat excited; probably the effect of the ether. He had an intense desire to rub himself, which he did most violently for a long time; no other consequence.

No. 153.—A three-quarter-grown cat was put in a six-hundred-cubic-inch-jar, with fifteen grains of iodoform in one drachm of oleum æthereum; temperature, 70°. The oleum æthereum slightly decomposes the iodoform, and dissolves it only to a very limited extent. The saliva immediately began to flow, and flowed more copiously than I ever saw it; she appeared very uncomfortable and distressed in her breathing, and sat with her back planted against one side of the jar, and her feet on the opposite side, with her body swaying from side to side, gradually becoming duller and more sleepy until now, (eighteen minutes after being put in,) when she has sunk to the bottom of the jar asleep. At thirty minutes taken out, able to crawl in a very staggering manner about the room, appearing distressed, the heart beating so feebly as with the greatest difficulty to be felt. She soon passed a *very* large quantity of water, and immediately became much more comfortable. In five minutes she could run about

the room, and the heart had acquired pretty good power. In an hour she was well and eating; but little other effect was produced than that by the oil of wine.

No. 154.—A three-quarter-grown cat was put into a large jar, with fifteen grains of iodoform, partially dissolved in one drachm of rectified spirits of wine, in which it had been forty-eight hours with frequent agitation, for the purpose of getting it as much as possible dissolved. She was kept in during an hour. There was a very copious flow of saliva, and a good deal of distress, but very little, if any, more than the spirit itself would produce. When released, she was quite sensible, could walk about, and immediately set to work to clean herself; and when, in a quarter of an hour, offered the warm brain just taken from a dog, she at once eat it.

No. 155.—A three-quarter-grown cat was put into a six-hundred-cubic-inch jar, (temperature, 60°,) with twenty grains of iodoform, dissolved as far as it could be in one drachm of pyroxilic spirit. The only difference in the effect between this and No. 188 was that it was not so violent in its attempts to escape, and sooner became quieter. At an hour, half a drachm more of the spirit, with the remains of the iodoform, was put into the jar, without any perceptible effect. At two hours and a quarter, it was removed in a similar condition to No. 188; at the expiration of an hour, it had not quite so much improved, and the next day it was not quite so well as that, but afterwards it became perfectly well. I am not certain that the less violent struggles and the longer recovery in this cat may not be attributed quite as much to the fact of it being not altogether as powerful a cat as No. 188, as to any effect of the iodoform.

OLEFIANT GAS.

Heavy Carburetted Hydrogen; Bicarburetted or Percarburetted Hydrogen.—(Comp. C_2H_2. Sp. gr. 0.9810.)

No. 156.—A half-grown cat was placed under a jar holding six hundred cubic inches, into which ten inches of olefiant gas had been put, being rather more than $1\frac{1}{2}$ per cent. It was kept in during twelve minutes, without any effect being produced.

No. 157.—A strong cur pup, three months old, was put into the same jar, with fifteen cubic inches, = 2½ per cent., of olefiant gas. In three minutes he seemed sleepy, but with an appearance of uneasiness, and continued so until eight minutes, when he curled himself round and fell fast asleep, the breathing being rather laborious; but he was very easily roused. At twelve minutes he was taken out quite well.

No. 158.—A kitten, about ten weeks old, was put into the same jar, with thirty cubic inches of olefiant gas, = to 5 per cent. In nine minutes it became uneasy, and turned quickly round, cried out, struggled hard, and fell backward, gasping; the breathing became very irregular, with violent shrieks; the fæces were discharged, and it was insensible and unconscious. In twelve minutes it was taken out; after a minute, if *severely* pinched at the tail or foot, it could feel. It gradually recovered.

No. 159.—A kitten, of the same size as the last, was placed in the same jar, with sixty inches, = to 10 per cent., of olefiant gas. In one minute, it for a few seconds moved violently about, then suddenly fell insensible, and was taken out perfectly flaccid. The respiration had nearly ceased; the heart could be felt just moving. It lay perfectly insensible, as if dead; but in two minutes it could raise its head, and in five was nearly well.

No. 160.—An old male cat was put into the same jar, with sixty inches, = 10 per cent., of olefiant gas. There was very little effect for fifteen minutes, when twenty inches more gas were put in, = 13½ per cent. He soon gradually became dull and sleepy, then struggled a little, and afterwards appeared feeble. He lay asleep, and could bear the ears being pinched very hard without giving any indication of pain; but on the jar being struck, he slightly started. He was kept in for three-quarters of an hour after the second dose; on being removed he roused up, walked away, being quite strong, and having all his faculties.

No. 161.—A strong pup, six weeks old, was placed in the same jar, with one hundred cubic inches of olefiant gas, = to 1 in 6 parts. In one minute he became affected, cried out, and was distressed; in four minutes he lay down, being unable to stand. He continued to breathe, but was insensible, until ten minutes, when he was taken out dead. There was no motion of the heart, and cold affusion was tried without any effect.

Post-mortem examination immediately made.—Head: sinuses and vessels of the pia-mater filled with florid fluid blood; substance of brain not much injected; no effusion. Chest: lungs rather redder than natural. All the cavities of the heart moderately full, as were the venæ cavæ, and all the pulmonary vessels, with florid fluid blood; the blood in the left side of the heart being decidedly darker in colour than that on the right.

No. 162.—A half-grown cat, the same as had the $1\frac{1}{2}$ per cent. (No. 156,) without effect, was placed in the same jar, with 14 per cent. of olefiant gas. It was some minutes before being materially affected; it then fell, with irregular breathing and convulsion, without, however, altogether losing sensation. When taken out, at eight minutes, it could not make the least effort to stand, the respiration was very weak, and the heart beat rapidly and feebly, but in a few minutes it recovered.

No. 163.—A kitten was placed in a jar large enough for it to run round in, with 25 per cent. of olefiant gas. In less than one minute it became much affected, feeble, and panting; in two minutes it fell, convulsed, and immediately became insensible; the respiration continued for two or three minutes longer, when it was taken out dead.

CARBURETTED HYDROGEN.

Light Carburetted Hydrogen; Hydrocarburet; Marsh Gas; Gas of the Acetates, &c.—(Comp. $C H_2$.)

No. 164.—A young, but full-grown, cat was placed in a six-hundred-cubic-inch jar, (temperature, 60°,) into which sixty cubic inches of pure light carburetted hydrogen gas, = to 10 per cent., had been put. It was so unaffected, that at seven minutes it was busy licking off the wet that had got upon its hair in passing through the thin layer of water on the stand of the jar. In twenty minutes its breathing was just beginning to be rather distressed, but not more than the confinement in the jar would account for. On the jar being removed, it walked quietly away, altogether unaffected.

No. 165.—Another full-grown cat was placed in a five-hundred-cubic-inch jar, (temperature, 40°,) with eighty cubic inches of

the hydrocarburet, = to 1 part in 6. It was kept in for twenty minutes, and taken out unaffected, indeed quite well, except that the respiration was somewhat hurried, which, however, passed away directly.

No. 166.—Experiment repeated with another cat placed in a six-hundred-cubic-inch jar, with one hundred cubic inches of the gas, (temperature, 60°,) = to 1 part in 6. At two minutes, it was rather restless for half a minute; it then sat perfectly still. Towards the close of the experiment, (twenty minutes,) the respiration was rather hurried, and on being taken out, the heart was beating rapidly and feebly. It immediately became well.

No. 167.—The same cat as No. 164, being quite well, was placed in a five-hundred-cubic-inch jar, with two hundred and seventy-five cubic inches of the gas, being rather more than 1 part in 2. It sat perfectly still until two minutes, when for one minute it struggled violently: it was then again perfectly still until six minutes, when it for a minute repeated the violent struggles to escape; after this it became very sleepy and still, but was not at all insensible. The jar was removed at fifteen minutes, when the cat immediately jumped off the table and walked away, apparently little the worse, except that the heart beat very rapidly and feebly, and the respiration was very hurried, but in one minute and a half it mewed in a tone of distress, fell down, was somewhat convulsed, the fæces were passed, and it appeared as though dying; there was no anæsthesia. After one minute this passed off, and it presently got up, walked to the fire, was soon well again, and so remained. I am somewhat doubtful if these severe symptoms were not occasioned by myself. In these experiments the jars were placed upon a surface which fitted to them, and contained a thin layer of water, consequently, in passing the cats into the jars, they became somewhat wet; and as this animal appeared to feel uncomfortable, I was noticing it, and holding it upright to the fire when the symptoms commenced.

It is proper to mention that for a minute or two, in the middle of these experiments, the edge of the jar was to a slight extent held off the stand, to allow the carbonic acid to fall out, otherwise this would have interfered with the result; but as the carburetted hydrogen is so light, it would be mostly at the top of the jar, and comparatively unaffected.

COMMON COAL GAS.

A Mixture of Hydro-Carbons, with probably an Admixture of some form of Sulphur, Hydrogen, and other Gases.

No. 168.—The same young dog as No. 157, being perfectly well, was put into the one-thousand-eight-hundred-inch jar, with three hundred inches of common coal gas, = to 1 part in 6; temperature, 68°, Fahr. For a minute and a-half he stood with tail and ears erect, unaffected, but soon after dropped to the bottom of the jar asleep, without any appearance of distress. The breathing became short and panting, and the cheeks had the blowing motion; arising, doubtless, from the lips being so completely passive, that the expired air, in being forced out, distended the cheeks. He became so motionless, and the respiration so imperfect, that at six minutes and a-half he was taken out, apparently all but dead. For some minutes he lay perfectly flaccid and motionless, without any consciousness, sensation, or reflex action, the heart beating most irregularly, with great intermittance, and upwards of 120 per minute; while, at first, not even the carotid arteries could be felt to pulsate. Muscular power gradually returned, he was convulsed, the respiration and circulation improved, he perceived pain in ten minutes, in twelve could look about him and roll over, and in fifteen could walk staggeringly across the room. He perfectly recovered.

No. 169.—Same dog as No. 91, being perfectly well, was put into the one-thousand-eight-hundred-inch jar, with six hundred inches of common coal gas, = to 1 part in 3; temperature, 68°, Fahr. He sat down, and did not move a muscle, gradually, but quickly, sinking by his weight into the lying position. In a minute he was insensible, and in two had the blowing motion of the cheeks; in four the respiration became very slow and imperfect, and appeared as though it would be suspended; but afterwards this a little improved. He was allowed to remain in ten minutes; during the last five, he did not appear more affected than before. There was not the least appearance of uneasiness; in fact, he did not move. When taken out, he was quite unconscious, but reflex action was not altogether destroyed, though voluntary motion was. He was not so much affected

as the last preceding; the respiration and circulation soon improved; there was some opisthotonos. In five minutes he could move, when he was plunged into water for a moment; this roused him, he shook himself, shortly could walk, and presently became quite well.

No. 170.—Same dog as No. 168, fifty hours afterwards being perfectly well, was put into the one-thousand-eight-hundred-inch jar, with two hundred inches of coal gas, = to 1 part in 9; temperature, 68°, Fahr. In five minutes, there was little effect; he then became uneasy, with a low moaning noise, and laid down. At ten minutes he fell asleep, but was not altogether insensible; the head and neck were drawn backwards and upwards several times, but in a feeble manner, the hind parts of the body being perfectly still. He breathed quickly, but quietly, and with occasional deep inspirations; he was allowed to remain in for half an hour. When taken out, he was overpowered with sleep, and quite insensible; reflex action was not lost. The heart acted most feebly; the temperature of the body was 90°. He lay asleep for six minutes, when he awoke sensible, but dull, and could not stand, until ten minutes, when he could walk a little in a most staggering manner. He now wandered constantly about the room, crawling, or falling over everything in his way, not in the least avoiding them, and getting into every corner he could; the breathing was quick and feeble, and the heart very tumultuous, but with very little power. In an hour he had improved, and next morning was well.

No. 171.—Same dog as No. 169, fifty hours afterwards being perfectly well, was put into the one-thousand-eight-hundred-inch jar, with five hundred inches of coal gas, = to 1 part in $3\frac{1}{2}$. As before, he sat still, without moving a limb; he gradually became sleepy, and slipped down, resisting this, however, as long as he could. At three minutes he was asleep at the bottom of the jar, in an easy posture. At five minutes, on the jar being struck, he evidently heard the noise. Allowed to remain in until ten minutes, having been quite still, with the breathing gradually becoming more feeble and imperfect. When taken out, there was neither consciousness, sensation, nor reflex action; the heart acted very slowly and feebly; the temperature of body was 101°. He soon improved. In five

minutes, the heart acted with tolerable vigour; in eight, reflex action had returned; at ten, there was rigidity of the anterior extremities, the head, neck, and anterior part of body being drawn backwards, while the hind part of body and legs were quiescent and relaxed. At twelve minutes he retched and vomited his food; consciousness and sensation returned; soon after he made attempts to get up; when he did, he pitched backwards and forwards, and from side to side, like a man in a state of intense drunkenness. Recovered.

No. 172.—A cat, nearly half-grown, was put into a jar holding six hundred cubic inches, with one hundred and fifty inches of coal gas, = to 1 part in 4; temperature, 68°, Fahr. She became almost immediately uneasy; in one minute, fell; in two minutes, was for thirty seconds convulsed, then became perfectly still and insensible, with the respiration quick, then irregular and slow; at three minutes and a-half, it nearly ceased for a minute; at four minutes and a-half, breathed once or twice. Taken out at five minutes, the heart just beating without force; this soon failed, and there was no other sign of life, though shaking, artificial respiration and the cold douche were tried.

Post-mortem examination two hours afterwards.—Muscles still flaccid, and red in colour; blood all fluid, and *bright scarlet* in colour. Vessels of head not more congested than in other parts; indeed the brain appeared rather white, and the choroid plexuses were not congested. No effusion of serum on the surface, or in the ventricles. Lungs scarlet, but not unusually congested: right auricle and ventricle of heart contained blood, but were not distended; nor were the venæ cavæ nor pulmonary artery; left auricle more distended than any of the other cavities; left ventricle quite contracted and empty; the right ventricle was flaccid; the aorta contained some little blood; the pulmonary veins contained very little blood. The liver was very scarlet in colour; the mesenteric veins not congested. The intestines, the rectum as well, full of fæces; bladder nearly empty.

No. 173.—A kitten, about ten weeks old, was put into a six-hundred-inch jar, with one hundred inches of coal gas, = to 1 part in 6; temperature, 68°. It almost immediately turned about uneasily, breathed quickly, became unsteady, and fell in two minutes upon its side; it lay struggling, especially with its

fore feet, for a minute, then fell asleep, and became nearly, but not entirely, insensible until four minutes. Its respiration now became slow, feeble, and irregular. It was taken out at five minutes, unconscious and insensible, but with reflex action remaining. It soon improved; in three minutes it could move, in six was able to walk, and in an hour appeared nearly, if not quite well. As it recovered, the heart beat very tumultuously.

BENZOLE.

BENZINE; PHÈNE; BENZÉNE.—(Comp. C_2H; or, more probably, $C_{12}H_6$. Specific gravity of liquid 0.85; becomes a solid white chrystalline mass at 32°; boils at 187°. Specific gravity of vapour at 60° 2.738°.)

No. 174.—A three-quarter-grown cat was placed in a five-hundred-cubic-inch jar, (temperature, 60°,) with ten minims of benzole. It sat very little affected during five minutes, when it became dull, with some slavering, and some uneasy muscular movement, which gradually increased until it became continuous. At ten minutes it was lying at the bottom of the jar unconscious, but not absolutely insensible to pricking. On being removed, it immediately rallied, and in two minutes could walk. It was soon perfectly well.

No. 175.—A full-grown cat, which had been nearly starved, was put into a six-hundred-cubic-inch jar, (temperature, 60°,) with twenty minims of benzole. Up to three minutes it was but little affected, when it became much distressed, and had considerable muscular movement; at five minutes it was insensible, but sat supported against the side of the jar, with constant muscular twitching until fourteen minutes, when it sank in a quiet state to the bottom of the jar, with a rather noisy respiration; at fifteen minutes it was removed, having been for ten minutes perfectly insensible. The pupils were widely dilated, and there was no reflex action; the heart beat excessively quick and feeble; the movements in all the muscles immediately came on, and there was considerable râle in breathing. At five minutes it was certainly rallying, but still altogether flaccid and insensible,

when the cold douche was applied to the head and chest for a few seconds with the effect of decidedly rousing it for the moment, but it immediately relapsed into the same condition as before; a repetition of the douche had the same effect. It was now laid before the fire; it gradually acquired more power, and in fifteen minutes after being taken out, it got up, tumbled over a low fender, and crawled under the fire-grate, where for another ten minutes it sat in a stupid, dreaming condition, when a morsel of the flesh of the dog which was being examined was held near to her nose; she instantly started up, contended for it, at first without much consciousness, but in one minute she was as eagerly and collectedly seeking for more as could be. She remained well.

No. 176.—A large old male cat was placed in a six-hundred-cubic-inch jar, (temperature, 60°,) with thirty minims of benzole. He instantly tried to escape; in one minute and a half the saliva was running freely, and there was great muscular tremblings, which increased, until at four minutes it was as though the cat was in a most dreadful ague; these continued uninterruptedly until seven minutes, when they were not constant, but had increased into sudden, frequent, and violent spasms of different parts of the body. He had been insensible for some minutes. The breathing was stertorous, and so continued, with the spasms, until sixteen minutes, when he was removed, dead.

Post-mortem examination twenty-five minutes after death.—Body, which on taking out of the jar was perfectly flaccid, had already begun to stiffen; the muscles natural in colour. Chest: lungs crimson in colour; they did not collapse much, not from being solidified, but in consequence of the cells being filled with air, which, on slight pressure, passed out, and left the lungs very small indeed; pulmonary veins full. Heart: all the cavities were full, but not altogether so much distended as in the dog next mentioned; the left cavities were less distended than the right; on exposure, all the cavities shewed some little movement, but not sufficient to move the contained blood; this was black, or nearly so, but immediately on escaping, somewhat coagulated, and became rather more florid. All the abdominal viscera were congested; there was a slight peristaltic action. The bladder contained some little water, and the rectum was

quite full. Head: the sinuses, the pia-mater, and the substance of the brain were all congested, and the latter contained some serum on the surface, in the ventricles, and in its structure. In three hours after, the muscles had all become very rigid; the heart was nearly empty and contracted, and the blood more florid.

No. 177.—A young, but full-grown, small spaniel bitch was placed in a four-gallon jar, (temperature, 64,°) with one drachm of benzole. For five minutes there was very little effect; she then became restless. At ten minutes, she cried out in distress, and immediately became perfectly insensible; indeed, I never saw more profound anæsthesia: the breathing was stertorous. She lay in this condition to twenty minutes, when the mucous râle was so great, that I thought death inevitable; but at thirty minutes she was rather better, the anæsthesia was not quite so profound, and at one hour was so much improved, that she was able to get out of the jar, on the cover being removed: the benzole was all gone. The next day she was well, except much thinner than before the operation.

No. 178.—Twenty-four hours after, the same bitch was put into the same jar, (temperature, 60°,) with one drachm and a-half of benzole. She was immediately affected, tried to escape, and appeared distressed. In two minutes she was perfectly insensible, with very laborious breathing, and did not afterwards stir; in ten minutes she was dead.

Post-mortem examination immediately.—At first the body was flaccid, but during the examination became much more rigid; muscles natural in colour. Chest: lungs of a brownish grey colour, rather solid to the touch, and full of black blood; pulmonary veins much distended; the bronchial membrane was rather congested, and the glottis contained some tenacious mucus. Heart flaccid; *all* the cavities excessively distended, as were the venæ cavæ; there was not any contractile movement of the heart's fibres; its own vessels were not particularly distended. All the abdominal veins were much distended; there was not any movement of the diaphragm, on the phrenic nerves being divided in this or in No. 176. Head: all the sinuses, vessels of the pia-mater, and of the brain greatly congested; the substance of the brain contained some serum; blood, on escaping, coagulated, and became lighter.

Forty-eight hours after death.—Lungs of a liver colour; all the cavities of the heart still full of blood, especially those of the right side; the blood all black, and nearly fluid; there was a coagulum, but so soft, as scarcely to be called one; the heart was flaccid, and the body was not very rigid.

CAMPHOR.

As Camphor is a Hydrocarbon, not differing very essentially in its composition from the Oxide of Ethyle,—the formula of this C_4H_5O, and of the former $C_{10}H_8O$, the principal difference being that the proportion of Carbon and Hydrogen are reversed,—it appeared to be worth trial, it being of course necessary to dissolve it, in order to render it sufficiently vapourizable to be inhaled. Specific gravity 0.9857 to 0.996. It melts at 347°; boils and sublimes at 400°. Density of vapour, 5.317.

No. 179.—A four-months'-old dog was put in the four-gallon jar, with one drachm of camphor, dissolved in two drachms of spirits of wine; temperature, 74°. At one hour taken out, he appeared to suffer very little; at the early part he was rather restless, but afterwards lay down, quiet and sleepy, at the bottom of the jar. There was not the least loss of consciousness or sensibility, and when let out he ran about the room, but presently became dull and crept very close to the fire, where he lay for two hours, at which time the heart could scarcely be felt beating. The next morning he was quite well.

No. 180.—An adult cat was placed in the six-hundred-cubic-inch jar, with thirty minims of oleum æthereum, holding in solution five grains of camphor; temperature, 65°. In twenty minutes, as very little effect had been produced, another drachm of the oil, containing ten grains of camphor, was put in. The cat was allowed to remain in during an hour. It continued for nearly half an hour almost unaffected; it then became sleepy, lay perfectly still and easy, the pupils being much dilated. When removed it was conscious, but unable to stand. In a quarter of an hour afterwards, it could walk in a staggering manner, and was soon quite well again.

No. 181.—The same three-quarter-grown cat, which forty-eight hours before had been in the turpentine, being quite lively and well, was put into a six-hundred-inch jar, with one drachm of oleum æthereum, containing ten grains of camphor; temperature, 58°. It sat with hardly any motion, unaffected, for ten minutes, when it began to slaver, and appeared very weak. In half an hour it was very sleepy, lay perfectly still, and when disturbed seemed annoyed, but was quite conscious; after which it became more awake, and on being removed, soon appeared as well as ever, and shortly was actively contending for food, (the warm flesh of the dog that had just been destroyed by the turpentine, the body of which was being examined.)

No. 182.—Same cat, twenty-four hours after, put into the same jar, at a similar temperature, with one drachm of pure oleum æthereum, and kept in during an hour. The effects were very similar. There was perhaps not so much saliva escaped, and perhaps it was rather more sleepy, but there was no material difference.

No. 183.—The large male cat, which forty-eight hours before had been subjected to the turpentine, being perfectly well, was put into a six-hundred-inch jar, with one drachm and a-half of sulphuric ether, containing ten grains of camphor; temperature, 58°. For a quarter of an hour he sat without having once stirred; he then struggled for a minute, and became again motionless and exceedingly sleepy, exhibiting a great disinclination to be disturbed; but he was not unconscious, nor altogether insensible. When removed, at the expiration of an hour, he had been for some minutes rousing up, and on being taken from the jar, was nearly in the same state as when put in, and in a short time quite ready for food.

No. 184.—Same cat as last, twenty-four hours after, was put into the same jar, at the same temperature, with one drachm and a-half of pure sulphuric ether, and kept in for an hour. The effect was as nearly as possible the same as the previous night, except, perhaps, that the sleepiness continued till the termination of the experiment, and when taken out he woke up more surprised and bewildered for a minute or two, but was soon ready for food.

NAPHTHA, (THREE VARIETIES OF.)

Purified Wood Naphtha or Pyroxylic Spirit—Bihydrate of Methylene.—(Comp. C_2H_3O Aq. = Me O. Aq. Boils at about 150°. Sp. gr. of liquid at 68° 0.798; of vapour, 1.120.)

Rock or Petroleum Naphtha—"Specific gravity, 0.755; and its formula is said to be C_6H_5."—*Turner*.

Coal Naphtha—Exact composition not given in the last edition of *Turner* or *Fownes*, and is probably somewhat uncertain.

No. 185.—A half-grown cat was placed in a six-hundred-cubic-inch jar, with thirty minims of rectified wood naphtha,—pyroxylic spirit; temperature, 60°. Up to a quarter of an hour it made continuous, but not very violent, efforts to escape; there was a good deal of irritation about the eyes and nose, with the saliva dribbling freely; it appeared weak and distressed. Half an hour: since fifteen minutes, has, for the most part, sat dozing, unsteady, and frequently mewing, but apparently not uneasy. Taken out sensible, but dull, very weak, and still; heart beating but feebly and rapidly; evidently feels cold, and most determinately persists in getting under the grate. Soon quite well.

No. 186.—A young, but nearly full-grown, rough-haired, terrier dog, was put in the two-thousand-cubic-inch jar, with one drachm and a-half of pyroxylic spirit, at a temperature of 60°. Fifteen minutes, has struggled and made considerable efforts to escape, up to this time; he now sits quiet, sleepy, and with the saliva dribbling from the mouth. Thirty minutes, since fifteen minutes, has sat still, and dozing quite comfortably. Cover now removed, he is quite sensible, but unable to get out of the jar, the heart beating very rapidly and feebly; runs about, and rubs his head and neck very violently upon the floor. Soon quite well.

No. 187.—A four-months'-old terrier dog was put in a four-gallon jar, with one drachm and a-half of rectified wood naptha; temperature, 60°. At forty minutes he was released; during the last half of the time he had been lying at the bottom of the jar dozing. When the cover was removed he got out, and was quite able to walk about, the heart beating quickly and feebly; not otherwise affected.

No. 188.—A three-quarter-grown cat was put into a six-hundred-cubic-inch jar, (temperature, 60°,) with one drachm of pyroxylic spirit. The saliva almost immediately flowed freely, and the eyelids were kept closed, evidently to avoid the irritation of the vapour. She made very frequent and violent attempts to escape, sitting still between them. As in an hour no other effect was produced, another half drachm of the spirit was put into the jar. This presently again excited her to renewed violent attempts to escape; she then lay down, very sleepy, but did not appear to be perfectly asleep, and more than once rose up and turned round. She was kept in the jar two hours and a quarter; when taken out, she was not absolutely, though very nearly, insensible; consciousness, I did not think, was lost in an equal degree with sensation; she could stagger about a little, and was perfectly saturated with her saliva. The heart beat rapidly and throbbingly, but with sufficient power to propel a feeble stream of blood into the larger arteries. She crawled to the fire, and crept under the grate, where she remained for an hour; she could then walk better. She was quite conscious, and could both see and hear quickly, but her sensibility to pain was certainly still materially lessened. The larger arteries felt as small as a fine thread, and there was a perpetual quivering of all the muscles, like the sensation in a rigor; this was very perceptible to the hand, but not to the eye. She was put into a warm place for the night. The next day she was feeble and thin, but could eat, and was certainly more recovered than No. 155, which had had the iodoform as a corresponding experiment, the two being placed side by side upon the same table.

No. 189.—The same rough-haired dog as had the wood spirit, No. 186, was put into the same jar, with one drachm and a-half of petroleum naphtha. Not much affected for ten minutes, then very uneasy; in fourteen minutes, there was a continued half-convulsive howling and great attempts to escape, with an appearance as though suffocating. He became weak and unable to stand, and continued to howl, but not loudly, with great restlessness, until twenty-five minutes, when the cover was removed. He had consciousness and sensation, but could not at first get from the jar; in one minute he did, the heart beating very rapidly and feebly, 185 per minute. He was weak, but soon appeared well.

No. 190.—The same dog as forty-eight hours before inhaled the wood spirit, (No. 187,) was now put into the same four-gallon jar, with one drachm and a-half of petroleum naphtha, (temperature, 60°,) and kept in three-quarters of an hour. He had been much distressed, and made attempts to escape, but for the last quarter had laid at the bottom of the jar, and could not get out himself, though he tried. He was not insensible nor unconscious, continued much distressed, and falling backward and head-foremost, rather than from side to side; heart very rapid. Soon improved.

No. 191.—A nearly full-grown terrier dog was put into a jar holding rather more than two thousand cubic inches, with one drachm of rectified coal naphtha; temperature, 60°. There were some bones in the jar, which he was busy gnawing when the naphtha was put in: this he continued to do during three minutes and a-half, when he ceased to do so, became restless, and tried hard to escape. In six minutes he was unable to stand; at twelve minutes he was removed. He continued exceedingly distressed, with the breathing very much oppressed, and as though unable to expand the chest. When removed, he was sensible to pain, but the faculties were blunted, altogether unable to stand, the heart moving with intense rapidity and feebleness; he appeared timid and frightened. In three minutes he was able to stagger about the room, rolling over, head-foremost: all the muscles were exceedingly tremulous. He was now quite conscious, and went staggering about the room for a few minutes, gradually improving, and in a quarter of an hour he was quite well and gnawing a bone, except the heart, which continued to beat rapidly.

No. 192—A three-quarter-grown cat was put in a six-hundred-cubic-inch jar, with fifteen minims of rectified coal naphtha; temperature, 67°. She was immediately affected, and seemed greatly distressed, but made no violent struggles, nor did she cry out. She was constantly convulsed, but not at all violently; first one set of muscles, and then another, as those of the jaw, or the ear, or of one limb, were in constant motion; and she became completely insensible. In four minutes she was removed, the heart beating too rapidly to be counted, and the convulsions constant, but not violent; altogether insensible and unconscious. In two minutes the convulsions a little ceased, at intervals; in

three minutes she appeared to have a little command over the muscles, in four minutes she was conscious, and in five minutes she could run about, having command over all the muscles. Soon well, except the heart, which continued to beat rapidly.

No. 193.—The same half-grown cat as an hour before had had chloric ether, from which, though recovered, she had continued excessively weak, was put into the same jar as the above had been removed from. She soon became convulsed and insensible, but as she was not speedily destroyed, more of the coal naphtha was added, and in twenty minutes she had for five minutes not shewn any signs of life, except the most feeble pulsation of the heart.

Post-mortem examination immediately, while the heart was still beating.—All the cavities contained blood, perfectly black; vessels of lungs congested; lungs themselves rather scarlet; trachea white; no mucus; blood coagulated immediately on escaping. Head: some little congestion of the vessels of the pia mater, with some little effusion; the brain itself not congested; sinuses of dura mater not congested.

No. 194.—A small carp was placed in forty ounces of water, (temperature, 60°,) with fifteen minims of rectified wood naphtha, or pyroxylic spirit. It appeared not at all affected until it had been in seven hours, when it darted in violent jerks about the water, lying still between them, and inclined to roll over upon the side. In twenty hours, it was rather dull and weak, could be touched without perceiving the approach of the finger, but when touched, it darted off with violence; in thirty hours, apparently quite natural, but in three hours afterwards it was found floating upon the surface of the water, dead.

No. 195.—A small carp was placed in forty ounces of water, (temperature, 60°,) with fifteen minims of petroleum naphtha. After remaining in six hours, appearing perfectly well, the only effect being the effusion of some little mucus, it was removed into the same jar in which No. 196 had been placed. In seven minutes it was dashing with excessive violence about the jar, and it was affected in precisely the same manner as No. 196; in an hour it lay floating upon the side, but with sufficient power to move about the water, though when handled it appeared to have no consciousness of it, and it could be rolled over and over in

the water without any apparent perception. It was kept in the solution six hours, being at the end of that time much as it was after the first hour. It was placed in pure water; after a few minutes it somewhat revived, and the next morning, eight hours after, appeared as well as ever.

No. 196.—A small carp was placed in four ounces of water, (temperature, 60°,) with fifteen minims of rectified coal naphtha. It almost immediately breathed laboriously and rapidly. In ten minutes it was dashing with excessive violence and rapidity about the jar; in fifteen minutes these motions were still continued, but with much less power; it was unsteady, rolling from side to side, bore handling without any indication of sensation, and, I think, could not see; at thirty minutes, it appearing about to die, without any sensation, even on being pricked with a pin, it was put into pure water, where, after a few minutes, it began to breathe, then to move, and in an hour it was nearly in a natural condition again.

OIL OF TURPENTINE.

(Comp. $C_{10}H_8$. Boils at 312°. Specific gravity of liquid, 0.86 to 0.87 ; of vapour, 4.764.)

No. 197.—An old mongrel terrier dog was put into a large earthen jar holding eight gallons and three-quarters, with two drachms of pure oil of turpentine; temperature, 80°. He sat quite still for twenty-five minutes, when he became restless, and made many attempts to escape; at thirty minutes, he appeared much distressed, and began to howl and bark, which he continued doing for nearly ten minutes, gradually, however, becoming weaker. He was now unable to stand, and lay constantly moving the legs, with the breathing stertorous, until the expiration of an hour, when he was removed from the jar. The heart was beating with excessive frequency; the respiration was also very frequent and panting, and though very nearly, he was not absolutely, either unconscious or insensible; he was somewhat convulsed, and altogether unable to stand. After a short time he improved, and struggled and rolled about the floor, as the succeeding cats, over and over again, often head-foremost. In an hour after

removal he was dull, and disposed to sleep, but in other respects nearly well, and could perform any of the muscular movements with tolerable precision.

No. 198.—An adult mongrel terrier, larger than the last, was put into the same large jar, with four drachms of oil of turpentine; temperature, 80°. After two minutes, he struggled very hard to get out, and howled for five minutes, when he became still. Consciousness continued until six minutes, when he was unable to stand; in eight minutes dead, almost as soon as he lost consciousness.

Post-mortem examination immediately.—Muscles, all of a dark colour; no quivering on being cut through. Lungs collapsed, and of an uniform dark crimson colour, exceedingly congested. Tracheal mucous membrane rather congested, but not to any great extent; more so at the glottis than at any other part; contained a little, but very little, mucus. Heart: all the cavities excessively distended; so much so, that the pericardium was put upon the stretch, and when partially cut open, the heart was protruded through the opening: venæ cavæ very much distended, as were the pulmonary artery and veins; the aorta also contained blood; the blood was at first all fluid, and rather dark, but immediately, on escaping, it coagulated; no effusion in the pleura or pericardium. Head: sinuses distended; pia-mater congested, with considerable sub-arachnoid serous effusion; brain itself not congested, and perfectly healthy in appearance; the veins generally were congested, and the arteries also contained blood. When the phrenic nerve was divided, the diaphragm was convulsed, but the division of other nerves did not cause any convulsive movement. The peristaltic action of the alimentary canal was very feeble.

No. 199.—A three-parts-grown cat was placed in a jar holding six hundred cubic inches, with one drachm of spirits of turpentine; temperature, 68°. She soon became uneasy, and tried to escape, but without any appearance of pain. At six minutes, the saliva began to drain very freely from the mouth, and the efforts to escape became more continuous and violent until eleven minutes, when she was violently convulsed, and fell insensible; so she continued until fifteen minutes, when she was removed from the jar, quite unconscious, but not perfectly insensible. The muscles

were not paralysed, but rigid, and with convulsive tremors. The heart was beating upwards of 200 per minute, very feebly. In ten minutes, the convulsions have continued, and do, but there is evidently now mixed with them some voluntary effort; in fifteen minutes, more power and consciousness, but she is still unable to stand; in half an hour she could do this, but in attempting to walk, immediately rolled over and over; is perfectly conscious, and pleased to be noticed; in three-quarters of an hour she could crawl and stagger, exactly like a *very* drunken man. Twelve hours after perfectly well, but thinner than before the experiment; as indeed was the case after several of the agents.

No. 200.—A large male cat was put into a jar holding six hundred cubic inches, with a drachm and a-half of spirits of turpentine; temperature, 68°. He sat perfectly still for two minutes, then made very violent efforts to escape. At five minutes and a-half the respiration had become very rapid and panting; at six minutes he fell, unconscious, with a violent struggle; at ten minutes he was taken out, unconscious and insensible, the heart beating very rapidly and feebly; reflex action not lost. Two minutes after, lay growling like a dog; and when a spoon was put into his mouth, most savagely bit it; sensation quite returned. In fourteen minutes attempts to get up, but unable; seventeen minutes, struggles violently and feels, but is unable to see; continues swearing and growling, can crawl, but constantly falling down, and is exceedingly cross. Twelve hours after, perfectly well; but, like the preceding, thinner than before the experiment.

No. 201.—The same cat as was in the camphorated oleum æthereum (No. 180,) was, forty-six hours afterwards, put into a six-hundred-cubic-inch jar, with one drachm of spirit of turpentine; temperature, 55°. Up to ten minutes he sat still; he then became very restless and howling, with saliva running freely from the mouth; in twenty minutes, he was convulsed with such exceeding violence, that he shivered the glass jar in which he was placed. The heart was beating with great rapidity, but so feebly as scarcely to be felt. He continued unconscious and insensible for two minutes; at five minutes he crawled, rolled, and dragged himself about the room, with the appearance of excessive giddiness; great weakness of, and want of control over, the muscles, but

sensible; gradually improved, and in three-quarters of an hour appeared much as usual, and quite ready to eat. The heart, however, was still beating rapidly and feebly.

CREOSOTE.

(Comp. $C_{14}H_9O_2$, according to Ettling; $C_{14}H_8O_2$, to Deville. Sp. gr. 1.037. Boils at 394.4°. It does not very rapidly evaporate.)

No. 202.—A full-grown cat was placed in a six-hundred-cubic-inch jar, with twenty minims of creosote, and kept in two hours and a-half, during the whole of which time she seemed perfectly easy and comfortable, made no effort to escape, sitting still and happy. She never lost consciousness nor sensibility, but when taken out was dull, indisposed to move, and the heart was beating rapidly and feebly; a good deal of saliva had escaped. The next morning she was dull, and not disposed to eat, but during the day much improved in appearance, though she certainly was ill. She was afterwards destroyed by the injection of acetic ether into the vein, having in the interval been subjected to the vapour of chloric ether. The condition of the lungs being probably dependent upon the action of one of these respired substance. See No. 255, &c.

No. 203.—A three-quarter-grown cat was put into a six-hundred-cubic-inch jar, with half a drachm of acetic ether, and twenty minims of creosote dissolved in it; temperature, 70°. At twenty-two minutes, taken out; she had neither lost consciousness nor sensibility, but for the last some minutes had been still and sleepy; during the whole time had been very dull and distressed. Though weak, she was able to run when released, the heart beating very rapidly and feebly; quite wet from the saliva, which was freely effused.

No. 204.—A nearly full-grown bull-terrier dog was placed in the eight-gallons-and-three-quarter jar, with thirty minims of creosote dissolved in a drachm of oleum æthereum; temperature, 74°. For half an hour he was restless, and made many attempts to escape, but afterwards became quite still. When the cover

was removed from the jar, at the expiration of an hour, he jumped out perfectly well, and so continued.

No. 205.—A three-quarter-grown cat was placed in a six-hundred-cubic-inch jar, with half a drachm of creosote; temperature, 69°. Very shortly she became affected, and continued very uneasy and distressed, but was not in the least insensible or unconscious. She was kept in the jar an hour; when taken out, she crept under the grate, was very weak, with the heart beating very feebly, and she was quite wet with the saliva which had flowed. In half an hour she appeared much more dull and ill than when taken out. She persisted in lying under the grate, after being withdrawn, perhaps twenty times, and got the hair a good deal singed from the hot cinders. The next morning she was found dead.

Post-mortem examination next day.—Muscles rigid. Chest: lungs presented the same appearance as in No. 255, but not in so considerable a degree; the bronchial membrane was not congested; the right side of the heart was congested and flaccid; the left auricle contained a little blood, the ventricle none, and it was contracted; the aorta and pulmonary artery contained blood; the venæ cavæ were distended; there was no effusion. Head: sinuses of dura mater not much congested; the pia-mater was so, both on the surface and in the ventricles; brain natural; no effusion.

PROTOXIDE OF NITROGEN.

(Comp. N + O. Sp. gr. 1.5241.)

No. 206.—A half-grown cat was placed in a two-hundred-cubic-inch jar, filled with protoxide of nitrogen. She struggled violently for five minutes, gradually becoming weaker, then was comparatively still, until nine minutes. She breathed quickly and laboriously, but did not completely lose either sensation or consciousness, and when released at nine minutes, she was able to walk, and immediately became quite well, the only effect being some dulness while in the jar.

No. 207.—A rather larger cat was placed in the same jar, filled with the same gas. She soon became more affected than the

last, and struggled very violently until five minutes, when she became nearly still. She was kept in until ten minutes, having for the last two minutes been perfectly still, with the respiration very feeble, though regular. When released, she was altogether unconscious, insensible, and without reflex action. A knife was passed three or four times through the skin of both fore-legs, and the nose was well pricked, without the least indication of feeling; but in half a minute there was a little indication of feeling, and in one minute this was very decided; in less than two minutes she could sit up, and in three minutes, except the action of the heart, which was feeble and rapid, she was quite well. In half an hour more the heart beat naturally, and she was playing as cheerfully as possible.

No. 208.—A half-grown cat was put into a four-hundred-and-fifty-cubic-inch jar of protoxide of nitrogen. She soon became affected; in two minutes could not stand; in four minutes was lying senseless at the bottom of the jar, feebly breathing. The tail was withdrawn, and two portions cut off, without the smallest indication of pain. Taken out at five minutes, dead. Artificial respiration was tried for some time, by a blowpipe introduced into the glottis, but without any effect.

Post-mortem examination in an hour.—Chest: lungs rather œdematous and pale; pulmonary vessels somewhat filled. Heart very flaccid; all the cavities contained blood, but none were particularly distended; venæ cavæ were full; aorta and pulmonary artery contained blood, all fluid and dark, alike in both sides of the heart. Head: no congestion of sinuses of dura mater; some little of the vessels of the pia-mater; none of the brain, which was rather dry.

No. 209.— A three-quarter-grown cat was placed in a four-hundred-and-fifty-cubic-inch jar, filled with protoxide of nitrogen. She was kept in thirteen minutes. When taken out, she was as conscious and sensitive as when put in; in fact, she was completely unaffected, except that the heart beat very rapidly and feebly. She had scarcely stirred during the whole time, and kept one foot held up, evidently to prevent it getting wetted. There was a very large quantity of vapour thrown off, and much carbonic acid generated, as proved by the action of lime water put into the jar.

No. 210.—Another cat, rather smaller than the last, was put into the same jar, with the same quantity of protoxide of nitrogen. She sat perfectly still, gradually becoming weak and dull, up to five minutes, then turned round several times, with extreme weakness, as though she would fall, but presently so much rallied as, at nine minutes, to be able to lick the water off her legs. At fifteen minutes, taken out; all dulness had passed away, and she was as well as when put in, except that the heart beat with such extreme feebleness and rapidity, as scarcely to be felt. When taken out, a taper burnt with a fuller flame in the jar than in the atmospheric air, shewing some of the gas still remained.

HYDROCYANIC ACID.

(Comp. C_2N Cyanogen + H = Hydrocyanic acid. Sp. gr. of liquid, 0.6969 at 64°; boils at 80°. Sp. gr. of vapour, 0.9476. Strength of Scheele's acid, 5 parts real acid and 95 water.)

No. 211.—A very strong young dog was placed under the six-hundred-cubic-inch cover, with five drops of Scheele's acid. In twenty seconds he became convulsed, but with nothing like the violence of the cat, (No. 215,) and he howled a little. In less than one minute he was perfectly still and insensible. On being shortly after taken out, he appeared as though dead, but there was some little motion of the heart, and he gradually recovered in a similar manner to the others.

No. 212.—A strong young dog, about three months old, was put into the three-hundred-and-seventy-five-cubic-inch jar, with three drops of Scheele's hydrocyanic acid. He became almost instantly affected, and tried hard to escape; he cried, became convulsed, and was perfectly insensible in a minute and a-half; in two minutes, he was taken out. He lay without stirring, feebly breathing, for twenty minutes, when he was slightly moved. Convulsions followed, and insensibility continued. In an hour and a-half, when put away for the night, though perception and sensation had returned, he was altogether unable to sit, stand, or crawl; in fact, there did not appear to be any muscular power.

The following morning he was quite well, running about as usual, but the heart's action was feeble and quick.

No. 213.—A four-months'-old dog was placed in a four-gallon jar, with two minims of Scheele's hydrocyanic acid, (temperature, 60°,) and kept in five minutes. He immediately attempted to escape, and feebly cried out for two minutes, then became nearly still, but was not unconscious until three minutes, when he was nearly, but not absolutely, insensible; at five minutes, he was not more so. Immediately on being taken out, he became conscious, and staggered about, falling head-foremost; he vomited while within the jar, and passed fæces afterwards; the heart's action was very quick and feeble. In one hour and a half, except being weak on his hind legs, nearly well, and runs about, but has sat, crouched in a corner, cold and dull, nearly all this time.

No. 214.—A half-grown cat was put into a six-hundred-cubic-inch jar, with two minims of hydrocyanic acid, (Scheele's,) and half a drachm of sulphuric ether; temperature, 60°. In half a minute she began gently to turn round, and the nostrils and eyes to water; in two minutes she made efforts to escape, and half convulsive struggles; in three minutes fell, and breathed in a puffing manner with the lips, and pantingly, otherwise perfectly still; at five minutes she had ceased to breathe, and was altogether insensible and motionless. When taken out, the only motion was the heart beating most feebly and rapidly. She gradually improved; in five minutes could feel and make a noise when hurt, but there was no motion in the limbs. She soon after became quite conscious, and lay howling; in twenty minutes was pleased to be noticed, and could sit, but not stand; in five minutes more she could crawl, and had ceased to cry. In an hour and a half, is now nearly well, except rather weak in the hind legs; she has continued cold and cross, sitting crouched in a corner, but now is pleased to be noticed.

No. 215.—A half-grown cat was put under a glass cover holding six hundred cubic inches, with five drops of Scheele's hydrocyanic acid; she sat still for a minute and a half, with the saliva freely dropping, when she became *most* violently convulsed for a minute, then for another minute lay perfectly still, insensible, only breathing convulsively; after which she only breathed twice. When taken out, at five minutes, she was dead. The fæces had been passed, but not the urine; this escaped afterwards.

No. 216.—A half-grown cat was put into a three-hundred-and-seventy-five-cubic-inch jar, with two drops (not so large as minims,) of Scheele's hydrocyanic acid; temperature, 68° Fahr. In one minute she began to turn round, and making increasingly violent efforts to escape, became convulsed; in two minutes she fell, unable to rise, but continued convulsed, first in one limb and then another, not altogether, but irregularly, the spasm becoming weaker and the insensibility greater until three minutes, when she was perfectly still and insensible. On being now taken out, she could bear pressure to any extent, and pricking, without the least indication of feeling; she was in a perfect state of anæsthesia. She lay for five minutes perfectly still, quietly breathing. Tremors were then perceptible over her body and limbs, then slight convulsions, which gradually became stronger and very violent. Sensibility and sensation returned; she could see and hear, but it was twenty minutes before she could in the least support herself; after this, she much more rapidly recovered. Though she was able to walk, yet for some time she was very unwilling to move. The fæces were passed while in the jar convulsed; the urine, in a very large quantity, as she became sensible, after being taken out. The following morning she was perfectly well.

No. 217.—Another cat, not quite so large as the last, was put into a two-hundred-and-forty-cubic-inch jar, with *one* drop of Scheele's hydrocyanic acid. She struggled as No. 214, until two minutes, when she was perfectly still, and, apparently, in a quiet sleep. She could not be roused, and did not manifest the least indication of sensation, on the web of the hind foot being transfixed, or the ear, nose, or tongue being punctured, nor on the ear and feet being forcibly pinched and tickled, yet reflex action was not altogether destroyed; neither do I think vision or hearing was totally lost. For two minutes, after being taken out, she lay perfectly still, then became convulsed, but not violently, and gradually improved; in twenty-five minutes she could just sit, but preferred to lie; even then her heart beat very rapidly, and her respiration was 130 per minute. In an hour, though quiet, she appeared well, and on the next morning was as active as usual.

As a further illustration of the effects of hydrocyanic acid when inhaled alone or with sulphuric ether, and the post-mortem

appearances resulting, I would refer to the experiments quoted in the foot note appended, from the *Transactions of the Provincial Medical and Surgical Association*,* for 1847.

CONIA, CONEINE, OR CICUTINE.

(Comp. $C_{16}H_{16}N$? Sp. gr. of liquid, 0.89.) "Boils at 338°, but distils at a much lower temperature when water is present."—*Turner.*

No. 218.—An active terrier dog was put into a jar, with two drops of conia; temperature, 68°. In fifteen minutes taken out unaffected; returned to the jar, with five drops; in twenty-seven minutes, on the cover being removed from the jar, though quite sensible and looking about him, he was so dull and feeble as not to make any effort to escape. The cover was removed in fifty minutes; he had during this time made no effort to escape,

* "No. 86.—A rabbit, one month old, and a kitten, fourteen days old, were put together into an oval preparation glass jar, of sufficient size to hold eleven pints, and to allow them to move about. Into this jar four minims of acid were dropped, and it was covered over. The kitten showed decided symptoms of being affected in twenty-five seconds; it struggled as though attempting to run, but unable to get a holding for the feet, it soon fell upon its side, and cried out feebly three or four times; at four minutes it had rather a strong convulsion, then lay still, breathing with great convulsive movement at intervals of a minute, the respiration becoming shorter and feebler until twenty-eight minutes, after which it did not stir. Examined one minute after it ceased to breathe.

"The rabbit was not decidedly affected until forty seconds, when it moved in a similar manner to the kitten, soon fell upon its side, breathed convulsively, making a low whining noise with each inspiration. It was dead in two minutes and a half, not having had any violent general convulsion; the pupils were natural, rather contracted than dilated; the eyes were not prominent nor injected; the mouth was as pallid as after death from any other cause. Examined five minutes after it ceased to breathe.

"No. 87.—It having been suggested to me by a scientific friend, that probably sulphuric ether might be usefully employed against the effects of hydrocyanic acid, I first ascertained that the vapour of it was not prejudicial to the animals by placing one for a quarter of an hour in the jar with twenty minims of ether, without any ill effect. I put a rabbit and kitten, of the exact size, (from the same litters,) as No. 86, into the same jar, with a similar quantity of acid, (four minims,) and twenty minims of sulphuric ether. In ten seconds the kitten cried out, in fifteen seconds struggled hard, and in twenty seconds fell upon its side; its mouth became intensely red, and the jaw closed with some foam about the lips. After breathing a few times it lay as

and during the last half hour had lain quietly down at the bottom of the jar, quite sensible. When the cover was removed, he got out of the jar with some effort, and could run about, though very unsteady on his legs, but was not otherwise affected.

No. 219.—A half-grown cat was placed in a six-hundred-cubic-inch jar, with two minims of conia. Fifty-two minutes; sat

though dead until three minutes and a half, when it was strongly convulsed, very rigid, and cried loudly in a natural voice; it then breathed at intervals of about one minute until twenty-four minutes, after which it did not stir. Before death, as rigidity went off, the redness of mouth disappeared. The rabbit was affected in twenty-five seconds, fell with hardly any struggling or noise, and did not breathe after one minute and forty-five seconds; mouth not red; eyes natural, pupils rather contracted than otherwise.

"No. 87.*—A half-grown cat was put into a jar, with two minims of acid and twenty minims of sulphuric ether. In forty-five seconds she became strongly convulsed for twenty seconds, then paralysed; at five minutes she was slightly convulsed, otherwise lay without any motion. The respirations gradually became feebler up to ten minutes, after which she did not breathe; both urine and fæces passed. In this case all the cavities of the heart contained blood; the right side and the two cavæ were more distended than I ever saw them.

"No. 87.**—A kitten, five weeks old, was put into the jar, with two minims of acid and twenty of ether. It cried and made many voluntary efforts to escape for two minutes, when it gradually became weak and paralysed. It was kept in the jar for fifteen minutes, during which time it continued slowly to respire, which was the only motion observed. There was not during the whole period the least appearance of convulsion. When first removed it breathed more freely, but only continued to do so for a minute. All the cavities of the heart contained blood, but not to the same extent as the last."—pp. 33, 34.

"No. 86.—Rabbit: poisoned in two minutes and a half, by respiring the vapour of hydrocyanic acid. Examined five minutes after it had ceased to breathe. Heart: some little clear serum in the pericardium, also in the cavities of the pleuræ. This was evidently just being effused, as on the pericardium being opened and the serum wiped away, the surface of the heart was soon again moistened by the exuding fluid. The left ventricle contracted and firm, the right ventricle filled, but not distended, with blood; the two auricles excessively distended, as were the coronary veins, the three venæ cavæ, (the rabbit has two descending cavæ,) and the pulmonary arteries and veins; the aorta and its branches were empty. The lungs were reddish in colour from the blood they contained; the two auricles and right ventricle contracted rapidly, but, apparently, without the power to propel their contents. Blood uniform in colour, muddy in appearance, and darker than natural. Brain not in the least injected; indeed, it might be called pale in colour: neither its membranes nor sinuses were filled; spinal marrow itself natural, not injected, nor was the spinal pia mater, but the vertebral sinuses, from top to bottom, were enormously distended with almost black fluid blood. During the time the brain and spinal marrow were examined the heart continued to pulsate. I cut through the cervical portion without effect, then cut out the whole dorsal and part of the cervical without effect, then cut

perfectly still until this time, gradually becoming dull, sleepy, and weak, but not unconscious, when she fell, insensible and convulsed, and continued feebly so for ten minutes, when she was dead. No motion in the heart could be perceived.

Post-mortem examination immediately.—Muscles rather pale in colour, veins not particularly distended. Chest: lungs much

away the whole brain and remaining part of the cervical spinal marrow, the heart still pulsating, and not being in the least influenced by the interference with the cerebro-spinal axis. The pulsation of the heart had not entirely ceased until an hour and a half after the animal had been placed in the vapour, eighty minutes after the heart had been exposed, and sixty minutes after the brain and spinal marrow had been removed; first the left auricle ceased, then the right ventricle, and, lastly, the right auricle.

"The examination of the kitten presented analogous appearances. There was serum effused into the pericardium and pleuræ; the lungs were reddish from the blood they contained; the right ventricle and the two auricles, with the coronary veins, were distended, but not to the same extent as in the rabbit, and the left ventricle contained some little blood; it, as well as the three other cavities, continued to contract, or rather to move; the aorta was not perfectly empty. Brain and its membranes not injected; in fact, the substance of the brain was white; spinal marrow natural; the dorsal sinuses, through the whole extent of the vertebral canal, filled with dark fluid blood, but not to the same extent as in the rabbit; entire brain and spinal marrow removed in the same manner as in the rabbit, with the same want of effect upon the action of the heart. It was not until at least six hours had elapsed after the whole cerebro-spinal axis had been taken away, and more than six hours and a half after it had breathed, that all the cavities of the heart ceased to move. This they did in the usual order, the left ventricle soon being empty, more contracted and quiescent, the right auricle continuing to move the longest.

* * * * * *

"No. 87.—Rabbit: died from the inhalation of the vapour of the acid, and of sulphuric ether. Opened three minutes after it ceased to breathe. Heart acting strongly: appearance of heart, blood-vessels and lungs exactly as in the preceding rabbit, with the same effusion of serum going on. Head and vertebral column not disturbed, in order to compare the heart's action with the preceding. Heart ceased to act in less than three hours; the ventricles, at least an hour and a half before the auricles; these continued nearly filled with blood, which, on the following morning, was found to be partially coagulated. The ventricles also contained a small quantity of blood; altogether the heart was not contracted so firmly nor completely as in the preceding case, or as is usually found.

"Kitten: death induced as the last. Chest opened in four minutes after it had ceased to breathe; the appearances were exactly as in the preceding kitten. Head and back not disturbed: the heart continued to contract for upwards of three hours, the auricles being very active; contrary to what I have almost uniformly seen, the left continued to act vigorously, probably from its containing blood. The following morning they still contained blood, alike in colour and fluidity, while the ventricles, especially the left, contained hardly any."—pp. 63, 64, 65.

shrunk, and rather red; pulmonary vessels somewhat distended, but not excessively; venæ cavæ full, but not greatly distended; right side of the heart full, but not excessively so; auricle, especially the appendix, in constant motion, and producing a wave in the superior vena cava; in the ventricle, feeble motion when pricked, but not sufficient to influence the blood within it; the left auricle contained some blood, and the appendix of it contracted a little on being pricked, but the ventricle, although containing blood, had no action; blood all dark. Heart quite flaccid. Head: sinuses of dura-mater, and all the vessels of pia-mater very much congested, the brain having more red points than usual; there was serous effusion, both upon the surface and within the ventricles; pupils greatly dilated.

No. 220.—A half-grown cat was placed in a six-hundred-cubic-inch jar, with two minims of conia. She sat nearly still until six minutes, when she was decidedly affected, had become very unsteady, and appeared very giddy. In eight minutes she was unable to stand, and had a peculiar jumping, convulsive motion; at nine minutes she was removed from the jar, totally insensible and powerless, the heart beating with extreme feebleness, which it continued to do for two minutes — dead. There was no respiration, and but little motion in the individual limbs after eight minutes.

Post-mortem examination immediately. — Chest: lungs much shrunken and pale, their large vessels containing black blood, but not excessively distended; trachea not congested; no mucus. Heart quite flaccid; all the cavities moderately distended with black blood alike on both sides, right auricle and ventricle, and left auricle, especially the appendix of the right auricle, being in frequent contraction, but the left ventricle also, when pricked, having some contraction. Head: sinuses and vessels of the pia-mater and the brain itself very much congested; blood very black and fluid, but immediately coagulating on escaping, the coagulum being very soft; some little serous effusion. Muscles pale; no contraction of the diaphragm, on the phrenic nerve being divided; and no quivering, on the other muscles being cut through.

No. 221.—A large male cat had given two minims of conia by the mouth. He was set down directly affected, swore,

vomited, took a sudden leap, staggered, then was unable to step, and became very unsteady upon his legs, not being able to move one of them. In two minutes he was unable to stand, and without consciousness or sensation. The heart continued to beat till six minutes and a-half, after which there was not any indication of life. During this time, the action of the heart was not particularly quick, but gradually became weaker. After the first two minutes, there was no respiratory movement; from the second minute to the fourth, only an occasionally feeble quivering motion of the limbs, not consentaneous. After the fourth minute, there was no other motion than that of the heart.

Post-mortem examination immediately.—Muscles exhibited no trace of quivering, on being divided; rather pale in colour. Chest: lungs pale and uncongested, shrunk in size; venæ cavæ and pulmonary veins full of black blood, but not immoderately distended; both sides of the heart containing blood, especially the ventricles, the right particularly, the auricle of it rapidly contracting and producing a wave of regurgitation along the upper vena cava to the commencement of the two venæ innominatæ; this regurgitory movement was not perceptible in the inferior vena cava at all; the right ventricle, on being pricked, frequently contracted, but not without the stimulus of pricking; the left auricle very seldom, but still occasionally, though feebly, moved; the ventricle moved two or three times very feebly, when pricked; the right auricle and ventricle, particularly the auricle, continued during half an hour to contract, (when it was left for the night,) but the contractions were becoming less frequent and more feeble, the fibres of the heart pale and cold, the blood beginning to coagulate, and the muscles to stiffen. Head: as the night was far advanced, I intended to have examined this the next day, but being unexpectedly called from home, and detained away three days, it was not opened until four days after death, the weather being cold; all the sinuses and vessels of the pia-mater were greatly congested, as was the brain itself and the choroid plexus; there was not any effusion either upon the surface or within the ventricles, and the substance of the brain was firm; no decomposition.

HYDROGEN—OXYGEN.

No. 222.—A half-grown strong dog was placed in a one-thousand-eight-hundred-cubic-inch jar, into which five hundred cubic inches of hydrogen gas had been put, with one thousand three hundred of atmospheric air. He remained quietly sitting for some time, then lay down and fell asleep; his respiration shortly became quick and laborious, and after a time very much so. The chest was quickly and fully expanded. He did not lose consciousness nor sensation; he was allowed to remain in the jar thirty-five minutes; for a time he was dull, weak, and indisposed to move; but he walked slowly about, then laid down asleep. A burning taper was immediately extinguished on being put within the jar. The temperature of the dog was the same both before and at the conclusion of the experiment, 98°. There was some vapour exhaled, but not nearly so much as when the dogs were placed in carbonic acid or coal gas, especially the former, where the quantity was remarkable.

No. 223.—A half-grown strong dog was put into a one-thousand-eight-hundred-inch jar, with eight hundred cubic inches of hydrogen, and one thousand inches of air. He sat perfectly still for eight minutes, then lay down very sleepy and dull, but quite conscious, breathing rather laboriously. At the end of half an hour, one hundred inches of oxygen were put into the jar; this he appeared to enjoy, and certainly became more lively. In ten minutes, after the addition, allowed to escape, which he did, jumping from the table quite well.

No. 224.—A very strong small dog, three months' old, was put into a jar holding six hundred cubic inches, filled, as nearly as possible, with pure hydrogen. He became more quickly dull and sleepy than the two preceding, and the respiration was quick and deep, but he continued perfectly sensible and capable of moving during all the time he was allowed to remain in the jar, which was *an hour*. After the first fifteen minutes the appearance of distress did not in any wise increase. When taken out he stretched his limbs in a very natural manner, as though he had been asleep, and then walked away. In the mean time the jar was well agitated to remove the air, then immediately filled with oxygen, and the dog, within two minutes after being taken out,

again put in it. So very little sensible effect was produced upon him for five minutes, that one of those present thought the oxygen could not be good, when, in order to test the purity of the gas, a match, from which the flame had been extinguished, was introduced; this instantly burst out into a blaze, and on it being repeated quickly, the flame became so large, that it came in contact with the long hairs about the dog's mouth; they instantly ignited, and the dog was one sheet of flame. The dog was instantly removed, when this directly ceased, but of course the experiment was brought to a termination by it.

CARBONIC ACID.

(Comp. CO_2. Specific gravity 1.524.)

No. 225.—A very strong but small dog, twelve weeks old, was placed in a large jar containing one thousand eight hundred cubic inches, into which one hundred and fifty inches of carbonic acid gas, = to 1 part in 12, were put. It was allowed to remain in the jar for fifteen minutes. No effect whatever was produced; it was quite lively and active while in the jar, and on being taken out.

No. 226.—A young bull-terrier dog about five months old, was put into the same jar, with three hundred inches of carbonic acid gas, = to 1 part in 6. He was allowed to remain in fifteen minutes: during the last five minutes he appeared distressed, breathed quickly and [illegible], but did not lose consciousness nor sensation. When taken out, he could stand, and immediately ran about the room, playing; the heart, however, beat quickly and feebly, while the pulse could not be felt in the brachial arteries.

No. 227.—A dog of the same size, age, and breed as the last, was put into the same jar, with six hundred inches of carbonic acid gas, = to 1 part in 3. The mixture could not support flame, for a taper was *instantly* extinguished. The dog was immediately affected; he fell down, breathed with great effort and distress, but did not lose consciousness for several minutes, and up to ten minutes could raise the head. This he did to the upper part of the jar, close to the edge, as though to get

the chance of any fresh air. He was allowed to remain in for fifteen minutes; during the last five he had been unconscious and insensible, but was evidently much distressed. During the whole experiment, the resemblance in appearance to a dying person was very close. There was none of the quiet condition which is observed with many anæsthetic substances. When taken out, he soon rallied, was sensible to pain in two minutes, could walk in three, and shortly was as well as ever.

All these dogs, while in the jar, exhaled by respiration a large amount of vapour, and gave out considerable caloric.

CARBONIC OXIDE.

(Comp. C + O = C O. Sp. gr. 0.9727.)

No. 228.—A three-quarter-grown cat was placed in a four-hundred-and-fifty-cubic-inch jar, containing a mixture of two parts of atmospheric air, and one part of carbonic oxide. She *instantly* became affected. In twenty seconds, she was rigidly convulsed for half a minute, then still; she was taken out in one minute, and did not stir afterwards. She was perfectly flaccid, and after the first half minute of being in the jar, only took two deep inspirations—dead.

Post-mortem examination an hour after.—Muscles not rigid, but subsequently became so. Chest: all the cavities of the heart contained blood, and its muscular structure was contracted; lungs very œdematous, and of a very bright scarlet colour; bronchial membrane not congested; all the blood of a *very* bright scarlet, alike on both sides of the heart. Head: not much congestion of the sinuses of the dura-mater; vessels of the pia-mater so much congested as to make the membrane look perfectly scarlet; the cineritious structure very red, the medullary natural; no effusion.

No. 229.—A pup, three days old, was placed in a four-hundred-and-fifty-cubic-inch jar, containing one-twentieth part of carbonic oxide. It was not much affected for five minutes, when it became uneasy and a little convulsed; its breathing gradually became slower and more laboured until seventeen minutes, from which time until twenty-five minutes, it only breathed three times;

thence until thirty minutes, it somewhat improved, and breathed seven times. When taken out, its breathing gradually became better, and in an hour it was as well as when put in.

No. 230.—A pup, of the same litter as the last, was put into the same jar, with one-tenth part of carbonic oxide. It was affected in two minutes, and in five minutes seemed as though about to die, and continued so up to twenty minutes, when it improved somewhat, and moved a little. Taken out in thirty minutes. It was soon as well as when put in.

No. 231.—A three-quarter-grown cat was placed in a six-hundred-cubic-inch jar, containing one-twentieth part of carbonic oxide. She was immediately affected; she breathed laboriously, and the saliva flowed from her mouth. In half a minute she was convulsed and sank to the bottom of the jar, and in one minute and a-half respiration ceased. She was taken out at two minutes, perfectly senseless and unconscious, but the heart still fluttering. She immediately breathed convulsively, then lay for two minutes as though dead, but in five minutes she had become sensible, and cried continually; at fifteen she appeared quite well, but cold, and would persist in getting under the grate.

No. 232.—A three-quarter-grown cat was put into a four-hundred-and-fifty-cubic-inch jar, with one-fortieth part of carbonic oxide. In one minute she began to be much distressed, and to howl; in two minutes, could not stand; from two to three minutes, there were the most violent half-conscious convulsions; she was then perfectly still, with slow, distressed respiration. Taken out at five minutes; the heart was beating, but there was no other sign of life. She lay for three minutes, then began to move a little, when she rallied, howled most dreadfully, and appeared wild and frightened like a mad cat, but presently became quiet and still. She crept under the grate of the fire-place, being (like all these animals after anæsthetics,) cold and sleepy for some time afterwards.

No. 233.—The same two pups (Nos. 229 and 230,) previously experimented upon, were placed in a one-hundred-and-eighty-cubic-inch jar, with one-third part of carbonic oxide. In twenty-five minutes they were taken out. The one that had been put in the one-twentieth part of carbonic oxide had not breathed after five minutes, the other breathed up to twenty minutes. When

taken out, the only sign of life was the faintest quivering at the tip of the tongue in this one; but in five minutes the first one breathed, and then the second, and so they continued to do at intervals, gradually improving for twenty minutes, when for some minutes remaining in the same state, in order to destroy them, they were placed in a jar of perfectly pure carbonic oxide. They continued to breathe in this for half an hour, respiration not having then entirely ceased in the second one. They were opened.

Chest: lungs of a bright scarlet colour, and emphysematous; all the cavities of the heart full of blood; both right cavities faintly contracted, the contraction *beginning in the upper vena cava;* all the blood was of a perfectly bright scarlet colour, fluid at first, but soon firmly coagulated; alike on both sides of the heart. Head: vessels of the dura-mater not greatly congested; pia-mater perfectly scarlet; substance of the brain natural, but watery when sliced; there was effusion upon the brain, and also within the pleura and pericardium.

No. 234.—A three-quarter-grown cat was placed in a five-hundred-cubic-inch jar, with five cubic inches of carbonic oxide, = 1 per cent. She was immediately affected, and in the course of two minutes became uneasy, howled, and breathed quickly for several minutes; was then convulsed and rigid; at ten minutes she became perfectly still, fast asleep, at the bottom of the jar, and so continued until twenty-two minutes, when she was taken out. She immediately rallied, and went staggering about for two or three minutes like a drunken man, then crept close to the fire, and was perfectly still; and was so half an hour afterwards, when put away for the night. Next morning she was quite well.

BISULPHURET OF CARBON.

(Comp. $C S_2$. Sp. gr. of liquid, 1.272; of vapour, 2.668. Boils at 110°.)

No. 235.—A cat, not quite fully grown, was put into a dry oval jar, holding a gallon and a-half, (temperature, 68°,) into which ten minims of bisulphuret of carbon were dropped. A cover was so placed as not wholly to exclude the air. She immediately began to struggle most violently, and made the

most determined attempts to escape for nearly a minute; she then sat still, with occasionally turning round, and appeared dull, with saliva dropping, or even running, most copiously from the mouth; at first it was quite clear and pellucid, but afterwards became thick and frothy; in fifteen minutes, on the cover being removed, she stepped out of the jar and walked away, but with a very unsteady and feeble, drunken gait, (like sea sickness.) In a few minutes she vomited freely, which appeared to afford great relief, and her manner became natural, although the heart for some time continued to beat so weakly and quickly, that it could not be counted. There was no loss of sensation, nor was there any of the deep-laboured respiration seen from breathing chloroform, sulphuric, nitric, or acetic ether.

No. 236.—The same cat, three days afterwards, was put into the same jar, with thirty minims of bisulphuret of carbon, the jar being covered as before. She, as then, instantly made the most violent struggles to escape, the sensation produced in the mouth and fauces apparently being most unpleasant; she gradually became quieter, and at fifteen minutes looked dull and stupid. On being taken hold of, she was vicious, and scratched my hands. She was kept in for thirty minutes, having by this time partially recovered from her dulness and heaviness, which were the greatest at twenty minutes. She did not lose consciousness or sensation; when spoken to, she heard, but looked bewildered, and crawled about the room, howling in the most horrible manner possible. This, however, I think, at least in part, arose from wanting to dung, and not choosing to do it in the room, as, on being turned out in the yard, she at once relieved herself, and became much quieter. An hour afterwards she was busy cleaning herself from the effects of the saliva which had flowed so copiously about her; she was very weak, but seemed happy, and sought to be noticed.

No. 237.—A cat, about four months old, was put in a tightly-covered one-gallon jar, with forty minims of bisulphuret of carbon; temperature, 68°. She instantly made most desperate attempts to escape, frothed much at the mouth, passed water, then gradually became quiet, and at two minutes and a-half was perfectly still. Taken out at five minutes, dead; the muscles perfectly flaccid; the pupils rather dilated.

Post-mortem examination twenty-four hours afterwards.—Muscles rigid; sinuses and vessels of the brain full; lungs rather red, but not much congested; a little brick-red fluid blood in all the cavities of the heart, but none of them were at all distended; neither were the venæ cavæ, nor the pulmonary veins; the pulmonary artery and aorta were empty.

No. 238.—A kitten, five weeks old, was put into a jar holding two hundred and forty cubic inches, with twenty minims of the bisulphuret of carbon; temperature, 68°. It was almost immediately affected, and tried *very* hard to escape; it became weak and unable to stand, cried much, and appeared distressed; the nose was red, and the saliva flowed freely; it was much convulsed. The limbs were rapidly moved, with a pawing motion. At five minutes, when taken out, it was unconscious and nearly, though not completely, insensible. There was some muscular power retained; the heart beat very feebly. On being taken out, it was purged. It soon improved, and in six minutes after it could walk, though very unsteadily; however, consciousness was restored, and in a short time it was quite well, and remained so.

No. 239.—A rabbit, five weeks old, was placed in a jar of the same size as the last, and with a similar quantity of the bisulphuret of carbon; temperature, 68°. Like the kitten, it was almost instantly affected; it also was much distressed, and similarly affected. At three minutes it cried for some time in a low, whining tone. When taken out, at eight minutes, it was perfectly unconscious, insensible, and all reflex action was lost. The heart beat very rapidly and feebly; all other muscular power seemed lost. At three minutes after removal, it convulsively rolled over and over; reflex action had now returned. In fifteen minutes consciousness and sensation had returned; though unable to stand, it could support itself upon its belly, and in twenty-five minutes it could just stand. In an hour and a-half it appeared quite restored, and eat its food; but the next day it was dull, and would not feed, and at the end of twenty-four hours it died.

No. 240.—A sparrow was put into a ninety-cubic-inch jar, with five minims of bisulphuret of carbon; temperature, 66°. After two minutes, it suddenly fell upon the side, with the eyes shut, and a constant and rapid fluttering of the wings, the legs being perfectly still; it remained in the jar for six minutes. When

taken out, it was not nearly so sleepy as those birds which had been in the ether, or oil of wine; the legs, however, were still, and altogether motionless, there being a little motion in the wings. After fifteen minutes, it looked about and noticed things. On being thrown into the air, it could use the wings, but not the legs; in half an hour it could just hop, and when put upon the perch sat; it was immediately asleep, and so remained when left for the night, two hours afterwards. The next morning it lay at the bottom of the cage dead, cold, and rigid.

No. 241.—A large frog was put into a jar holding fifty-six cubic inches, with five minims of bisulphuret of carbon. He instantly made great efforts to escape, which he continued for three minutes, gradually, however, becoming feebler; he now became perfectly motionless, and in five minutes, when taken out, there was neither consciousness, sensation, nor reflex action; in fact, he appeared dead. He was laid upon the table upon his back, when the least fluttering of the heart could be felt; this increased in frequency and force, without his stirring, until half an hour, when he suddenly raised his head, turned over, in a few minutes jumped off, and soon appeared as well as ever.

No. 242.—A similar sized frog was placed in a jar of the same size, with ten minims of bisulphuret of carbon. He was affected in every way in exactly a similar manner to the last, the increased quantity not making any apparent difference in the symptoms. When taken out at five minutes he lay as though dead: in three minutes, on being turned over, he slightly moved one hind leg, then both, the skin becoming covered with a frothy exudation. He now lay for three-quarters of an hour without stirring or breathing, when he began to respire. In an hour, reflex action had returned; in an hour and a-half, when left for the night, he was conscious, and the limbs were not quite so flaccid, but he could not move them, so that it was difficult to say if there were any sensation. The next morning he could move pretty well, and recovered.

No. 243.—A full-sized black slug (*Limax ater,*) was put into a six-ounce jar, with four drops of bisulphuret of carbon, and allowed to remain in five minutes. It immediately rolled about, shrunk up, and threw out a large quantity of mucus. On being

taken out, it was not altogether insensible to pricking. It lay still for nearly an hour, then gradually recovered. The next morning it was still, dull, and contracted, and not nearly so lively as that which had been placed in the sulphuric ether. During the day it died.

No. 244.—Two cockroaches were put into an ounce jar, with two minims of bisulphuret of carbon. They became immediately affected, seemed distressed, and their bodies became covered with a white, creamy effusion; in two minutes they were nearly motionless, and in four they were dead.

SULPHURETTED HYDROGEN—HYDROSULPHURIC ACID.

(Comp. H S. Sp. gr. of Gas 1.177.)

No. 245.—A strong, half-grown dog was put into a jar holding one thousand eight hundred cubic inches, into which thirty-six, = to 1 in 50, of sulphuretted hydrogen, were put. He was immediately affected, staggered, and fell insensible. He was taken out in eighty seconds, perfectly flaccid, the heart feebly beating with tumultuous throbs, (the arteries could be felt,) and he faintly gasped a few times, but this was the only sign of life.

Post-mortem examination one hour after death.—All the vessels of the head, the sinuses, those of the membranes and ventricles, and the vessels of the brain itself, were much congested, the blood being fluid and bright red. All the cavities of the heart contained blood; both those of the right side and the left auricle were much distended; the left ventricle was not; the venæ cavæ excessively distended; the pulmonary artery and veins filled; the aorta also contained blood; the heart was soft, and its fibres uncontracted; the blood was florid and fluid. Lungs of an intense colour, between scarlet and crimson, with dark mottled patches, full of blood; not much œdema; the bronchial membrane *white,* and altogether uncongested, but the tubes filled with white froth; all the abdominal viscera of a bright scarlet colour, from the blood they contained; forty-eight hours after, the blood had become partially coagulated, and black in colour.

No. 246.—A strong, but small, half-grown dog was put into the same jar, with nine cubic inches of sulphuretted hydrogen, = to 1 in 200. He was immediately affected, turned round, and fell convulsed. He was taken out in twenty-five seconds, quite insensible and rigid, the heart beating, and with gasping respiration: he soon became flaccid, and though the heart continued to beat for four or five minutes, at least a fluttering motion could be felt as long, and the cold douche was tried, he did not move after being taken out.

Post-mortem examination forty-eight hours after death.—Appearances differed very little from the above, the blood being black and imperfectly coagulated, as in the former dog, after the same time had elapsed.

BROMOFORM.

Perbromide of Formyle. (Comp. $C_2H B_3$. Sp. g. 2.10.)

No. 247.—A six-months'-old small dog was placed in a six-hundred-cubic-inch jar, (temperature, 62°,) with five drops of bromoform. He was not at all uneasy, but gradually became sleepy, his movements being, apparently, more to find the most comfortable position than from any other cause; he did not lose consciousness nor sensation, but lay at times asleep, then awake, until twenty minutes, when the breathing became very laborious, and he appeared overcome with sleep, but could still be easily roused. At three-quarters of an hour, being less sleepy, he was released: he ran about perfectly well, the only effect being that the heart beat for a short time somewhat feebly and rapidly. The bromoform was all exhausted.

No. 248.—A cat, not quite full-grown, was put into a six-hundred-cubic-inch jar, with eight drops of bromoform; temperature, 62°. She very soon became sleepy, and appeared perfectly easy; in fact, she scarcely moved, except as the limbs slipped, in her sleepy condition, from under her, to find a more comfortable position; she did not lose consciousness nor sensation, and was easily roused from sleep. At twenty minutes she appeared more affected, and the breathing for five minutes became very

laborious; at half an hour she had improved, and on being set at liberty, she immediately jumped off the table. The heart was beating quickly and feebly, the pupils were dilated, otherwise she was unaffected. The bromoform was not all exhausted.

No. 249.—A strong, middle-sized mongrel dog was put into a four-gallon jar, (temperature, 65°,) with twenty drops of bromoform. He sat perfectly still, and became sleepy; but on the cover being raised, he made attempts to get out of the jar until half an hour, when he no longer did so, but sat quietly asleep, unless roused. At forty-five minutes, the bromoform being nearly exhausted, the cover was removed; at first he lay still, but presently jumped out and walked about, quite well. The fæces were shortly passed, and he was thirsty.

No. 250.—The same small dog as No. 247, being perfectly well, was put into the same jar, (temperature, 65°,) with twenty drops of bromoform. He immediately became sleepy, and gradually sunk into a lying position; he moved his limbs occasionally, but they were often in a most unnatural position; he could be roused, and, though very nearly, he at no time completely lost sensation. At an hour, the bromoform being nearly exhausted, on the jar being removed, he rolled off the table on to the ground, and appeared much surprised at finding himself there. He was immediately conscious, got up, walked about, drank water, and in five minutes was as well as ever.

In none of these experiments was there the least cough or irritation of any kind whatever produced.

INJECTION INTO THE VEINS.

No. 251.—A small, active bull-terrier (the hair having been cut close on the left fore-foot,) was placed in a three-ounce jar, containing one drachm of chloroform. After a quarter of an hour he became still and sleepy, appearing very comfortable, but with the heart beating rather irregularly; so he continued during an hour, when it was found that the sensibility was considerably diminished, but by no means destroyed. On the skin being cut, very florid blood freely flowed. When set at liberty, he wished to sit still, and appeared very sleepy; he held the foot up, but

could use it. An hour afterwards the right femoral vein was laid bare, and two ligatures put round it; the lower one was tied, and a minute opening made in the vein above it. The point of a very small syringe was introduced, and ten minims of chloroform injected, the upper ligature being then tied. He was set down; within thirty seconds he struggled hard, and howled loudly, *exactly as after hydrocyanic acid;* then fell, rigidly convulsed for a minute, when respiration ceased, and the muscles became flaccid. The heart could be felt to move until three minutes, but this was the only movement perceptible—dead.

Post-mortem examination eighteen hours after death.—Muscles rigid. Head: vessels of the meninges and the sinuses full of blood; substance of brain rather pale than not; the ventricles contained a little quite clear serum. Chest: lungs small and shrunken, slightly emphysematous, scarlet in colour, and also having many dark patches of colour. Heart: pericardium containing a little clear serum; right auricle and ventricle distended, with partially coagulated, soft, dark blood; venæ cavæ much distended; left auricle nearly empty; the ventricle was firmly contracted, but contained a small quantity of dark blood, partially coagulated.

No. 252.—A strong, young setter dog had injected five minims of chloroform into the femoral vein. In half a minute he struggled hard, howled loudly, and became both insensible and unconscious, but in the course of three minutes consciousness returned, and he was soon perfectly well again. In half an hour, twenty minims were well injected into the same vein, half an inch above the former aperture. On being put down, he attempted to turn round, but in so doing fell backwards, and neither uttered a sound nor moved: he did not breathe, and the heart could scarcely be felt to pulsate for two minutes, when for a few times it beat more strongly, and there was one faint gasp; after which, there was no indication of life.

Post-mortem examination eighteen hours after death. — The appearances were so similar to those in the last dog, that it is unnecessary to repeat them.

It is not without importance to mention that in making the first injection the vein was wounded, and the blood escaped freely at first, but immediately the chloroform took effect the hæmorrhage

stopped, and as its effects passed off, the bleeding returned: on the second injection two ligatures were used, so that no blood escaped.

No. 253.—A four-months'-old dog had injected into the right internal jugular vein ten minims of sulphuric ether. He immediately struggled hard and convulsively, became rather dull and sleepy, but neither lost consciousness nor sensation, and was comparatively little affected. In ten minutes, being nearly well again, twenty minims more were injected into the same vein, which produced but little more effect than the first dose. The femoral vein was cut open immediately after the first injection: one drachm, or perhaps two drachms of dark blood escaped at first; but after the second injection, none escaped, even when he walked away. This was, perhaps, owing to a small thrombus which formed about the aperture; but had there been much disposition for the blood to flow, this would not have prevented it. He walked into a corner, and there lay down and soon fell asleep, but he did not completely lose either consciousness or sensation, and in a short time appeared nearly well. The jugular vein was secured with two ligatures, one above and one below the aperture, but the femoral was not interfered with; there was no subsequent hæmorrhage. The next day he was quite well, allowing for the wounds. This was a very small dog.

No. 254.—A nearly full-grown dog had two drachms of sulphuric ether well injected into the left internal jugular vein. He was affected before all could be got in; instantly put down senseless and rigid; did not breathe for one minute, then took one long inspiration; the convulsive rigidity ceased, and the muscles became flaccid. He breathed convulsively six or seven times; the heart fluttered for three minutes, but there was no other motion; not a limb was stirred.

Post-mortem examination in twenty minutes.—Chest: lungs of a bright crimson colour; a little effusion in the pericardium; the right auricle and ventricle of the heart excessively distended; one small portion of the *sinus* of the right auricle for a few times shewed some little motion; left auricle full; left ventricle nearly empty and contracted; pulmonary veins and venæ cavæ excessively distended; pulmonary artery quite full; aorta contained blood. Head: sinuses of dura mater much congested;

vessels of pia-mater quite full; substance of the brain also congested, as were the choroid plexuses; a little serum effused both upon the surface and in the ventricles. When the dog was first opened, the blood was of a very bright red colour and fluid, but in the course of a few minutes, both that which escaped and that which remained in the vessels and in the heart, became of a dark maroon colour, and softly coagulated. Blood taken from the right side of the heart, examined under the microscope, shewed no alteration in appearance.

No. 255.—A large male cat had twenty minims of acetic ether injected into the right internal jugular vein. He was affected before the whole could be injected; instantly put down insensible and unconscious, in rigid convulsion, which continued one minute; he then became perfectly flaccid, and only inspired three times; the heart feebly pulsated for two minutes, when he was dead. Immediately the ether was injected into the jugular vein, the femoral was cut in two, but not more than three or four drops of blood escaped. Blood, under the microscope, did not show any change.

Post-mortem examination instantly.—Chest: the appearance of the lungs more resembled a mahogany table than anything else, being dark red in colour, and mottled all over with large, deep maroon patches;* substance dry, and having a feeling of solidity; bronchial membrane much congested; no mucus in it, nor œdema of lungs; pulmonary veins full, but not excessively distended; venæ cavæ distended, but not excessively so; right auricle and ventricle of heart full, but not greatly distended; left auricle contained some blood, as did the left ventricle; vessels of heart not much congested; blood all black. Head: no congestion of sinuses of the dura-mater; vessels of the pia-mater considerably congested; brain natural; no effusion. Blood, examined immediately under the microscope, did not shew any alteration in the figure of the globules.

* This appearance of lungs was, I believe, the effect of the creosote which the cat had inhaled three days before, since which time he had been very dull, with loss of appetite. (See No. 205, which experiment was made for the purpose of ascertaining the correctness of this opinion.)

INTERNAL ADMINISTRATION.

No. 256.—A young, but full-grown, vigorous, black and tan terrier bitch, (same dog as No. 3,) had thirty minims of chloroform given by the mouth. She ran about, and in two minutes began to rub first one side of the neck then the other, most violently; which rubbing soon extended to the shoulders, then to the entire body, and continued for five minutes. She appeared, perhaps, rather weak in the hind legs: in other respects, was not affected, and in six minutes was as well as ever.

No. 257.—To an active terrier dog one drachm of chloroform was given by the mouth. He ran about somewhat excited, but soon appeared rather weak, and evidently suffering from the smarting of the mouth, rubbing his neck violently, but perfectly conscious. In ten minutes he made attempts to vomit, but only brought up a little white froth, appeared very weak and unsteady, and the heart beat very rapidly and feebly. His surface felt cold, and there was a great disposition to turn round; the retching of frothy mucus continued for a few minutes; neither consciousness nor sensibility were affected. In the course of half an hour, except dulness, he was nearly well again, but was very much inclined to be still, not moving, unless forced to do so.

No. 258.—To a young dog one drachm of chloroform was given by the mouth. The mouth and fauces immediately became very red, and he evidently was very uncomfortable, suffering considerable pain: he ran about with the mouth open and the tongue protruding, rubbing the head, neck, and sides with considerable violence, but not the least loss of consciousness nor of feeling ensued. In fact, it acted merely as a violent local stimulant, not producing more effect, if so much, as an equal quantity of alcohol. In a short time he was perfectly well. The next day he was destroyed by one drachm of chloroform, given by inhalation, by means of a warm sponge. (See No. 4.)

No. 259.—Same cat as No. 13; gave thirty minims of chloroform by the mouth. It appeared to make the throat uncomfortable, and for some minutes she sat still, slavering very much, otherwise she was not affected by it.

No. 260.—A large, full-grown cat had given by the mouth thirty minims of chloroform. She became rather weak, especially

in the hind legs, and staggered; a little white froth came from the mouth; the surface was cold, the heart beat feebly and quickly, but neither consciousness nor sensation were in any degree lost, and she was in half an hour as well as ever again, but very still. The next day she appeared as usual, but quiet and sulky, and would not eat. The following night she was found dead and rigid, having escaped from the hamper and hid herself.

No. 261.—An old bitch had one drachm of chloroform well given by the rectum, by means of a large blow-pipe introduced three or four inches into the gut. The fluid was forced in by blowing strongly, and not a drop was lost; the bowels were once open after four minutes, but there was no tenesmus nor purging; no effect was produced. She was very eager for food, and eat well immediately after the chloroform was given, and also in half an hour.

No. 262.—To a terrier dog (the same as had one drachm of chloroform given by the mouth forty-eight hours before, No. 25,) one drachm of spirit of wine was given by the mouth. In consequence of his violent struggles, he lost half. Another drachm was given in five minutes, part of which again was lost. Five minutes; has been constantly wandering about, rubbing his head and neck; he appears nipped, shrunk, and cold; foams at the mouth, and seems altogether very uncomfortable; pulsations of heart, 145 per minute. Fifteen minutes; has vomited white frothy mucus, has gradually been getting weaker, and is now laid down, with the breathing very rapid and laborious; thirty minutes, bronchi completely loaded with mucus, is very cold, dull, not conscious, and likely to die. There is little doubt that in struggling and retching, while the spirit was in the fauces, some portion passed into the trachea. The next day he eat some bread and milk, but vomited it, and was very unwell; but before night he took a good meal of milk, meat, and bread.

No. 263.—A full-grown cat had given by the mouth forty minims of the chloride of olefiant gas. No other effect was produced than the local irritation; the saliva flowed freely for a few minutes, she ran about as though in pain, and the membrane of the mouth was red; but these symptoms presently subsided.

No. 264.—To a very large rabbit forty minims of pure alcohol

(specific gravity 797,) were given by the mouth. No effect was produced; a little, but very little, was lost in the giving of it.

The same quantity was given to a three-quarter-grown cat, with as little effect. The mouth was sore, and there was a little purging.

No. 265.—To the same bitch as had the drachm of chloroform by the anus, No. 261, one drachm of spirit of wine was administered forty-eight hours after in the same way. She was immediately purged, and soon weak, dull, and quiet, which continued for nearly half an hour; she was not otherwise affected, except that the heart beat quickly and feebly, in which condition she was put away for the night. The next morning she was perfectly well.

No. 266.—A strong, three-months'-old dog had twenty minims of chloroform introduced within the rectum, by means of a tube put as far as possible up the gut. Considerable straining and tenesmus were produced, but neither loss of consciousness, sensation, nor motion. In less than half an hour the dog was as well as ever.

No. 267.—Experiment repeated upon a dog of the same size and age, with forty minims. There was evidently pain, and after he had had it for five minutes there was some dragging of the hind extremities, and he appeared dull for a short time; this soon passed off. The straining and tenesmus were considerable, with some prolapsus.

No. 268.—Experiments repeated upon two young cats. To one ten minims, and to the other twenty minims, were given in a similar way, and with exactly the same results.

No. 269.—Two three-months'-old dogs had, the one twenty minims, and the other forty, of sulphuric ether given by the rectum in the same manner as the last. No anæsthesia was induced, but pain, forcing, and considerable irritation, with a frequent straining to stool and passing of water; which, however, soon, in a great degree, disappeared.

No. 270.—Two young cats had in a like manner, respectively, ten and twenty minims of sulphuric ether, with similar results, but which did not so soon pass off as in the dogs. No anæsthesia.

No. 271.—Two three-months'-old dogs had, the one twenty, the other forty, minims of oleum æthereum; as with the preceding, there was evidently heat and smarting, with straining to pass

stool, and, in that which had the largest dose, some dragging of the hind legs, but no anæsthesia. They were soon well again.

No. 272.—Experiment repeated upon two young cats, with ten and twenty minims respectively. Effect the same as in the dogs.

No. 273.—Two young dogs had similar experiments, with fifteen and thirty minims, respectively, of the bisulphuret of carbon. There was not any anæsthesia, but great distress. The tenesmus was distressing, with considerable prolapsus; the protruded membrane was excessively red and covered with mucus. The symptoms of distress lasted longer than with any of the previous agents.

No. 274.—Two young cats had, respectively, five and ten minims of bisulphuret of carbon: the symptoms were exactly similar to those of the dogs, except that in the one which had the largest dose the prolapsus was very considerable, and the tenesmus very excessive. The next morning, sixteen hours after, at least two inches of the entire circle of the gut was protruding, as congested as possible, with constant tenesmus and great contraction of the abdominal muscles; but not the least anæsthesia was, or had been present.

In this case I was nearly falling into a considerable error, as I now regard it, which I may here mention, to show how easily (if it be an error,) such might have been committed. I looked at the kitten, which, with half a dozen other cats and young dogs, was in a very large hamper, where they had passed several nights in the greatest harmony, and found the gut in the state first described. Within a quarter of an hour after, it was found straining very hard, and with nearly all the small intestines hanging from the rectum; it was immediately killed. At first I supposed the prolapsed gut had given way under the constant straining, and thus the intestines had escaped. On examining the parts carefully, the entire calibre of the rectum immediately above the sphincter was found divided in as straight and clear a manner as though cut with scissors. This, however unusual, appeared to be a decided case of self-laceration, where the gut had given way under the influence of its own action, the transverse muscular fibres having actually, by the intensity of their contraction in opposing the further prolapsus, completely divided the gut. But I am inclined to think this was not the case, and to conclude that one of the young dogs had been tempted by the

prolapsed gut, and had bitten it off. This is only supposition; but it is more probable than the first one, especially as one of the young dogs was a most ravenous one, and, as I afterwards was informed, had the day before scratched up and eaten a kitten which had been destroyed and buried.

The above experiments are quite sufficient to prove that most anæsthetic substances do not produce nearly the same effect when given internally as they do when inhaled; a considerably less dose thus administered would not only have caused insensibility in all, but, as was actually proved by experiment, in some death.

PROLONGED INHALATION.

No. 275.—A four-months'-old cat was put into a gallon jar, with ten minims of chloroform; temperature 68°. The jar was not entirely covered over, a small portion being left open at each end, (the jar being oval,) so that the animal should not suffer from the deterioration of the air. The kitten was soon under the influence of the chloroform; and as the effect passed off, another portion was added, so as constantly to keep up the effect. At each addition there was some excitement, struggling, and sometimes convulsions, otherwise the cat lay perfectly still, as though asleep; the heart beat rapidly; the breathing was at times very quiet and feeble, at others slow and deeper. The fæces and urine were passed more than once. It was taken out of the jar three times, wiped clean and dry, and allowed to remain out four or five minutes while the jar was washed out and dried. When least under the influence it was offered meat and milk, but during the whole period it would not touch either. At the end of thirty-eight hours it was dead. It had gradually become weaker, and for several hours had scarcely stirred in any way; indeed it was hard to say whether it was alive or not, and for the last eight hours no fresh chloroform had been put into the jar, and the cover had in a great degree been removed, so that during this time it could scarcely be said to have been subjected to the chloroform.

Post-mortem examination. — Head: no effusion; vessels of pia-mater much congested, those of the substance of the brain

but little so. Chest: lungs shrunk, but with a crepitating, emphysematous feeling; scarlet in colour, and with much blood effused in several places, as black patches. Heart small, and rather flaccid, its proper vessels being much congested; there was a little blood in all its cavities, but none of them were by any means distended; the blood was dark, and very softly coagulated, being alike in colour on both sides; the venæ cavæ were filled; the pulmonary artery and the aorta empty.

No. 276.—A cat of the same age (four months,) was placed at the same time in a similar jar, with thirty minims of nitric ether. The jar was covered in the same manner, and the treatment as to removal, &c., the same as the last. The animal continued thoroughly fast asleep, but not altogether insensible to pain; it appeared perfectly comfortable, often purred, and had a great dislike to being disturbed. When taken out of the jar and roused up, it instantly lay down asleep. It would not eat nor drink; it did not appear to suffer in the least, except when fresh portions of the ether were added, when it always struggled hard, and appeared distressed. It passed water, but not fæces. It gradually became weaker, and in twenty-two hours was dead. It died just as it had lain asleep; indeed it had been so little alive for some time, and had so gradually sank, that it was rather difficult to say when it actually was dead. The ether was renewed five times.

Post-mortem examination.—Head; no effusion; the vessels of the pia-mater were congested, those of the substance of the brain were not. Chest: the lungs were dark, with some patches of dark effused blood; all the cavities of the heart contained some little blood, but not much; the blood in the cavities, as well as that in the great vessels, was all fluid, and very dark; indeed, black.

No. 277.—A half-grown cat was put into the three-hundred-and-seventy-five-cubic-inch jar, the temperature, covering, and other circumstances being similar to those of the two last, with fifteen minims of oleum æthereum, which, from twenty to thirty minims, was frequently renewed (as often as ten or twelve times,) each addition exciting attempts to escape, and struggling, but not convulsions, for two or three minutes; otherwise it was perfectly happy, generally fast asleep, often, but not at all times,

insensible to pricking; and, when not asleep, perfectly contented, and purring. When taken out of the jar and roused, it was ready enough to eat, and could walk. The fæces and urine were passed more than once, and the jar was washed out and dried three or four times. At the end of forty-eight hours, no oleum æthereum having been added for seven hours, (during the night,) the cat being quite cheerful and well, it was taken out. It immediately eat, ran about, and cleaned itself. It was soon active and well, but much thinner than before the experiment. It continued permanently well.

No. 278.—A kitten, about fourteen days old, too young to lap, was put into a two-hundred-and-forty-inch jar, all circumstances being similar to those of the foregoing, with fifteen minims of oleum æthereum. This dose was frequently repeated, so as to continue the influence of it. Each fresh dose always excited struggles and cries; when these ceased, which they did in the space of a couple of minutes, it lay perfectly still, fast asleep, and at first, after each renewal, insensible; but as the effect of the dose was passing off, it became uneasy and cried. At the expiration of fifty-eight hours it had become very thin and weak, and evidently was suffering much from starvation. Successive and larger doses, as much as thirty minims, of the oleum vini not doing more than sending it to sleep. I destroyed it by the introduction into the jar of seven drops of the bisulphuret of carbon. Violent convulsions were immediately excited, and in a few minutes it was dead.

No. 279.—A fellow kitten to the last was put into a similar jar, and with precisely corresponding circumstances, with twenty minims of acetic ether. The doses being repeated so as to keep it constantly under the influence of the ether, each dose excited cries, struggles, and convulsions, for one, two, or three minutes; it then lay perfectly still and comfortable until the effect had nearly subsided, when it, as the last, became uneasy and restless. The effect of each successive dose lasted longer than the previous one. At the end of forty-eight hours, (for several hours previously it had lain motionless, except breathing very slowly,) the cover was entirely removed from the jar, and no more ether given. The next morning, fifty-eight hours from the commencement, it was lying in exactly the same spot and position as the previous night,

and evidently had not stirred. I thought it dead, as after watching it for some time, I could not perceive any respiratory motion; but on taking it up, it most feebly breathed, and continued to do so, with a few cries, so low as scarcely to be audible, for two hours more, not otherwise, however, having any motion or giving any signs of life. During all this time no food whatever could be taken. The urine was freely passed, but not the fæces.

Post-mortem examination.—Head: no effusion; the vessels of the dura and pia-mater congested; those of the substance of the brain not. Chest: lungs crepitating, and reddish in colour; the pulmonary vessels not distended. Heart rather distended; all the cavities contained some blood, but those of the *left side considerably the most, and the blood in them was quite dark;* the right cavities, especially the ventricle, contained but little blood; it was brick-red in colour, thin, and watery. The pulmonary artery and aorta empty; the venæ cavæ moderately full; the bronchial membrane perfectly white and uninjected; no mucus in the trachea. The fleas upon the creature were not killed.

No. 280.—A fellow kitten to the last was put in a similar jar to the last, all other circumstances being the same, with twenty minims of sulphuric ether. The effects were very similar, except that on the addition of each fresh dose the cries and struggling were not nearly so great as in the preceding. It was dead in forty-four hours. It is my opinion this creature was not quite so vigorous as the last kitten.

It is worth remarking, as showing the more destructive character of chloroform, the different effect upon the fleas, which all these cats were more or less infected with. In this, as well as the last of those submitted to the influence of the oleum æthereum, the fleas were unaffected, and as the animals became cold they appeared upon the surface very active, whereas they were uniformly destroyed in those animals which were submitted to chloroform; and in these a very minute drop of chloroform being afterwards allowed to fall near to them was sufficient very quickly to destroy them.

Post-mortem examination.—Pia-mater not at all injected; brain white, and almost bloodless. Chest: lungs pink in colour, and crepitating; pulmonary veins moderately filled with black blood; pulmonary artery and aorta empty; venæ cavæ moderately filled; left auricle of heart contained some blood, the ventricle not any;

the right ventricle contained very little blood; the auricle was moderately filled, but not by any means distended. The blood was a soft jelly, and equally dark upon both sides of the heart. Bronchial membrane nearly white; not any mucus in the trachea.

No. 281.—On the 17th, at seven p.m., a seven-days'-old kitten was placed in a two-hundred-and-forty-cubic-inch jar, (temperature 60°,) with four minims of chloride of olefiant gas. It was soon asleep. During the evening, at intervals of an hour, four minims were put in six times, (in all twenty-four minims,) when it was left for the night. The next morning (the 18th,) it was lying still asleep, but was easily roused on being touched, when it was taken out and put to the cat, which it sucked freely, and was well cleansed. It was immediately returned to the jar, with four minims of the liquid; this was repeated at intervals during the day nine times, (in all thirty-six minims,) with the effect of keeping it quiet and asleep. At three p.m., and again at seven p.m., it was put to the cat, but could not suck. The last dose, at eleven p.m., excited it at first when put in; before, this effect had not been observed. 19th, nine a.m., asleep, but soon roused; taken out and put to the cat, which it sucked well. Returned after an hour to the jar, with six minims, which, to half-past seven, were repeated three times. During the day it lay perfectly still, except when touched, when it roused up and crawled about; during the day its eyes became opened. It was taken out, and put to the cat, which it well sucked, was made clean and dry, and in half an hour returned to the jar, with six minims of the fluid. This was twice repeated in the evening. At night it appeared exceedingly dull and likely to die. 20th, half-past eight a.m., after watching it for some minutes, I thought it dead; but on taking it up in the hand, there was the faintest respiratory movement. All day it lay with the jar uncovered, never stirring, and rarely breathing, excepting when touched; its temperature fell to that of the room. A little fæces and urine escaped. Towards evening, seventy-two hours after being placed in the jar, it had so far rallied as to be able to stir, in the faintest manner, the limbs when touched. It was put with the cat, who warmed and cleaned it. As it was found to have revived, but not to have been able to suck, it was left with the mother during the night. None of the fluid had been given to it during the day. 21st, nine a.m., being quite active and

well, it was returned to the jar with six minims of the fluid, which was twice repeated during the day: in the evening it was just breathing. On being put to the cat, cold and wet, it was cleansed, but being unable to suck or move, the mother soon left it. In an hour again put in the jar, with four minims of the fluid: this was repeated at half-past eleven p.m. 22nd, nine a.m., it lay in exactly the same position as last night, and really appeared to be dead, but on handling it, the faintest respiration was perceptible. It was of the same temperature as the room, and contrasted strongly with the kitten in the following experiment. It was put to the cat, who again cleaned it, but it did not rouse nor suck. After two hours it was put into the jar, with four minims more: it never stirred after. The respiration became slower, but however, did not altogether cease until seven p.m., or one hundred and twenty hours after being put into the jar.

Post-mortem examination immediately.—Body without and within of the same temperature as the room; quite flaccid; muscles natural in colour and appearance. Head: all the vessels rather full of fluid blood; brain full of serum. Chest: lungs, of a pale pink colour, did not in the least collapse; pulmonary vessels all full of blood; bronchial membrane white, with the trachea and all the small tubes and cells filled with frothy mucus; a little fluid in the pericardium; both auricles of the heart equally and quite distended, and actively moving, indeed, with considerable contractile force; the right ventricle full, but not distended like the auricles, and also contracting; the left ventricle having little movement, contracted, and empty. The action of the cavities was irregular; sometimes the two auricles contracting together, at others not; sometimes before the ventricle, at others immediately after;* both venæ cavæ quite full; there was only slight regurgitation on the auricles contracting; blood alike on both sides, rather dark; abdominal veins rather congested; liver of a pale pink colour, like the lungs; stomach quite full of milk, which, as it had not sucked for at least thirty-six hours, must

* In the Essay "On the Effects of Hydrocyanic Acid," before referred to, I have called attention to the curious fact of the independence of the movement of the auricles from the ventricles, and also of each other, as well as the difference in the persistence of the movements in these cavities.

have been undigested;* rectum quite distended with fæces; bladder contained a little urine. In two hours and a-half the limbs were rigid, the heart was firmly contracted, and *all* the cavities were empty, as were the venæ cavæ; the blood that had escaped had formed a soft coagulum, and was brighter in colour. In all, rather more than two drachms of chloride of olefiant gas were used.

No. 282.—On the 21st, at four p.m., a kitten, eleven days old, was placed in a two-hundred-and-forty-cubic-inch jar, (temperature, 60°,) with four minims of benzole. It became uneasy, with quick respiration, but was shortly asleep. Up to midnight, at intervals of two hours, five minims of benzole were put into the jar, with the effect of keeping it for the most part quiet. 22nd, nine a.m., the kitten is dull, but conscious; cries when touched, and is very restless. The sides of the jar are covered with a watery vapour, the kitten feels quite warm to the hand, and the inside of the jar is 10° hotter than the outside. Put to the cat for two hours, having sucked well: returned to the jar, with six minims of benzole, which, during the day, were repeated four times. In the evening, for an hour, again put to the cat, who cleaned it and suckled it well. 23rd, nine a.m., quite awake as yesterday; the jar is filled with vapour and quite warm; more saliva has escaped than before, which has made all the under parts of the animal quite wet. Put to the cat for an hour, cleaned and suckled; returned to the jar, with six minims of benzole, which at intervals were repeated five times during the day. In the evening it was with the cat for an hour, and suckled. For the most part it lay perfectly still, with quick, uneasy respiration, but for a minute or two, after each addition of benzole, cried, then became perfectly still and asleep. 24th, nine a.m., quite quiet, but not asleep; temperature not so great as yesterday. Put to the cat for three-quarters of an hour, cleaned and suckled; returned to the jar, with six minims of benzole, which was repeated at twelve and two o'clock. At seven p.m. it was put to the cat, who cleaned it, but it would not suck. During this day it had been very quiet, with quick,

* Though the milk last taken remained in the stomach undigested, that which it had previously taken, while under the experiment, was digested and absorbed. The eyelids opened at the ninth day, as is usual with cats, showing that the functions of organic life were not at once destroyed nor even suspended.

uneasy respiration, and with some muscular tremblings, which, towards evening, had become constant; returned to the jar, with four minims. During the evening the temperature of the cat and inside of the jar fell to that of the room; the sides of the jar were, however, still covered with drops of expired water. Twelve p.m., five minims more benzole put in; though even when handled, it is now nearly motionless, and the respiration is most imperfect. 25th, a.m., lying in exactly the same position as last night, dead and cold, eighty-eight hours after being first put into the jar. In all, nearly two drachms of benzole were used.

Post-mortem examination immediately.—Muscles rather paler than natural, and soft. Head: all the blood-vessels full; the brain very watery and soft, nearly a pulp. Chest: lungs, of a pink colour, with here and there patches of crimson; as these were principally in the most depending parts, position possibly may have had something to do with their appearance; the lungs did not collapse, the cells being full of frothy mucus, but neither the trachea nor larger bronchial tubes contained any; the bronchial membrane not at all congested; pulmonary vessels full. Heart large and uncontracted; *all* the cavities equally full; on dividing the pericardium, and exposure to the air, all the cavities began to move, more especially the two auricles, and at the same time they all shrank in size, and became rigid; in half an hour they were *all* empty and firmly contracted.* The venæ cavæ full, but not distended. The abdominal viscera were not congested; the stomach contained some little milk; the gall-bladder was full; the rectum contained fæces, and the bladder was enormously distended. The blood was all of a pale brick-red colour, and appeared little more than coloured water, and scarcely coagulated on escaping. Thirty-six hours after: heart not so rigid as at two hours after examination, but empty, as were all the large vessels; the blood that had escaped was black in colour; decomposition just beginning. The muscles of this kitten did not become so rigid as those of the last.

* In the Essay before referred to I have directed attention to the different condition of the cavities of the heart when examined immediately, or not until some hours after death has occurred from hydrocyanic acid. It will be observed that I have done the same in several of the experiments now recorded, where the same appearance was observed; but this experiment is of great interest, inasmuch as the change was actually watched as it took place under the eye. I shall have occasion, when speaking of the *modus operandi* of these agents, to refer more particularly to this fact.

REMEDIES.

Ammonia, Cold Affusion, Agitation, Cold Air, Bleeding, Galvanism, Oxygen.

No. 283.—A moderate-sized young, but full-grown, and very active springer dog, had given thirty minims of chloroform upon a sponge, wrung dry out of water of 100°, Fahr. He struggled hard against it for forty-five seconds, during which time the bowels were opened, with considerable straining, but little more than mucus and flatus were passed. After one minute and a quarter he did not move the limbs, and after two minutes he did not respire; nor from two to three minutes could the heart be felt to move, when its motions could again be just perceived. The sponge was now removed, the heart still feebly pulsating, there being, however, no respiration, nor any other sign of life. In four minutes after the sponge had been removed, (seven minutes from the commencement of the experiment,) ten minims of the liquor ammoniæ fortis, with a small portion of water, were put into the fauces. As this did not produce any effect, twenty-five minims more were given, after the lapse of three minutes; and artificial respiration was kept up, without any advantage, until twenty minutes, when cold water was pumped upon the chest and back for a few seconds with as little effect. This dog appeared to feel almost instantaneously the influence of the chloroform. He was an exceedingly well-bred, lively, active dog, and I had not the least intention to kill him. When the sponge was removed, it still contained chloroform; from the strong smell, I should think half remained.

Post-mortem examination forty-eight hours after death.—Lungs of a dark crimson colour, but not black, like No. 292; bronchial membrane red from congestion. The right auricle and ventricle of the heart contained some very soft, dark-red coagula, but were not distended; the left auricle and ventricle contained a very little dark blood; the venæ cavæ and the pulmonary veins, as well as those of the general system, were all excessively distended; the stomach was full of food; the bladder was empty.

No. 284.—A very large, old male cat was placed in a three-hundred-and-seventy-five-inch jar, with twenty minims of chloroform. In one minute he passed a *very* large quantity of urine,

(for some hours before being placed in a box to prevent his escape, I suspect he had abstained from passing his water,) and made desperate attempts to get out; he then sat still asleep, and was insensible to pricking and pinching, but reflex action was *not* destroyed. He was removed from the jar after a few minutes, and his head held under a tap of water; he immediately roused up, but soon, in a great degree, relapsed. The jar was cleaned out, and the cat returned to it, with twenty minims of strong liquor ammoniæ. This produced some irritation of the nostrils, but had little effect in rousing him. The bottle containing the ammonia was then held close to the nostrils; he immediately and suddenly snatched his nose away, but beyond this, no material effect was produced. Certainly the douche with the water was far more effectual than the ammonia, though it was only partial. He gradually recovered in the usual manner.

No. 285.—A two-months'-old kitten was put into a jar holding two hundred and forty cubic inches, with thirty minims of oleum æthereum; temperature, 60°. It sat still, slavering, for three minutes; it then tried to escape, and became convulsed for two minutes. At five minutes it fell fast asleep, was insensible, and did not afterwards stir, except breathing slowly and quietly, the heart beating feebly and rapidly. It was allowed to remain in the jar for forty minutes. When taken out, a good shaking was tried but with little effect; it was then fanned with as little, and cold affusion was tried with none. After being laid down, in a few minutes it acquired some little power: as this returned, it howled a good deal; and, without being able to rise, forced itself round and round. On the douche being now again tried, rather more effect was produced, and a repetition of the shaking was more decided. After twenty minutes it was able to walk, but was still very weak. Recovered.

No. 286.—A young dog was put under the six-hundred-inch cover, (temperature, 65°,) with two pieces of lint, one of which was saturated with thirty minims of chloroform, and the other with thirty of the strongest liquor ammoniæ. He struggled hard to escape for a minute, then lay quietly down; in two minutes and a-half he tried to raise his head, but could not support it; there was some little moaning, and in less than five minutes he was fast asleep, quite insensible. He lay without the least

motion, except that of respiration, until sixteen minutes, when there was much blowing motion of the lips, with some convulsive motion of the head coincident with respiration,—phenomena often witnessed in animals under the action of chloroform, and always indicating the system to be considerably under its influence. He continued in the same condition until the end of half an hour, when appearing somewhat revived, he was taken out altogether insensible, but not perfectly motionless. The cold douche was applied to the head and neck with little effect; then a good shaking was tried without much more; however, he gradually revived, but the heart's action continued to be very quick and feeble. He rallied in much the same time and with much the same appearances as in those where nothing was done.

No. 287.—A two-months'-old kitten was placed in the two-hundred-and-forty-inch jar, with forty minims of oleum æthereum, and twelve of strong liquor ammoniæ, *mixed together*. It instantly made very violent struggles to escape, which were continued for half a minute; it then sat still, slavering, until two minutes, when it became insensible and strongly convulsed for one minute, after which it lay perfectly still, in a most contorted position, as left by the somewhat sudden cessation of the convulsions. The kitten recovered, but was long in doing so.

No. 288.—A strong, but small, young hound dog was put under the six-hundred-inch cover, at a temperature of 60°, with one drachm of oleum æthereum upon bibulous paper. For fifteen minutes he sat perfectly still, and apparently as happy as possible, the only effect being some little slavering, when he was let out for three minutes; after which he was returned to the cover, with half a drachm of chloroform. With the exception of a little slavering, he now remained quite unaffected for four minutes, when he suddenly became most violently convulsed and insensible, howling dreadfully; quite as though under the action of hydrocyanic acid. This continued for ten minutes, gradually, however, becoming weaker. He now became perfectly still, with the respiration rapid, upwards of 100 per minute. At twenty-two minutes he was removed; he immediately began gradually to recover, and in ten minutes was quite fresh and active. He was now returned to the cover, and the experiment with the chloroform repeated. The effects were similar in kind, but more speedy,

though not nearly so intense, except the insensibility, which was as great. At fifteen minutes he was removed from the cover, and the femoral vein divided; there was *no hæmorrhage whatever*. He soon acquired some muscular power, and some little sensation. The head was put under the douche; this decidedly roused him: he tried to escape, and shortly could stand. As sensation and motion returned, there was some little, but not much, bleeding from the divided vein.

No. 289.—A young dog was placed in a jar with chloroform, and allowed to remain until fully under the influence of it, but still breathing feebly and slowly when taken out. The external jugular was immediately divided, as were several of the veins in the neck in an extensive wound, but *not any blood whatever flowed.* When laid upon the floor the dog gradually came round, just as is usual when, with such a degree of narcotism, nothing is done; then, perhaps, a drachm of blood escaped. The wound was closed with two sutures, and healed rapidly, though from its size I had no expectation of its doing so, and at the time intended to destroy the dog.

No. 290.—An old male cat (same as No. 284,) was put into a jar with chloroform, and kept in until he was fully under the influence of it. Just as respiration appeared to be ceasing he was removed, and the neck opened immediately; the external and internal jugular veins and the common carotid artery were divided without any blood whatever escaping; the veins were all small. Did not recover; in fact, he scarcely stirred after being taken out of the jar.

No. 291.—To the old bitch that had the spirit of wine and chloroform by the rectum, (No. 261,) forty-five minims of chloroform were given, by inhalation, upon a sponge wrung out of water at a temperature of 65°. She made very little resistance: in one minute and a quarter, she was insensible, passed water, and attempted to howl; she continued to breathe feebly until three minutes and a quarter, and the heart could be felt pulsating until three minutes and three-quarters. The sponge was removed in four minutes, and the galvanic apparatus instantly applied, contact being broken every few seconds: an incision was made through the skin over the ribs, on each side, so as to transmit the current through the chest, when, by the mouth and anus, or the axillary

nerves, the action was continued for fifteen minutes, by which time muscular contraction had all but ceased to be excited by the wires. When an hour had elapsed rigidity had commenced. The blood, on immediately being examined under the microscope, was not found to present any abnormal character.

Post-mortem examination twenty-four hours after death.—Muscles rigid. Chest: lungs dark from carbonaceous matter, and emphysematous, (probably from age,) also red and congested; pulmonary vessels full, but not excessively distended: heart, hypertrophied, and much distended in all its cavities; the blood softly coagulated and black; aorta and pulmonary artery, and venæ cavæ full; mitral and tricuspid valves covered with large soft vegetations. Head: no congestion of any of the vessels, the little blood in those of the pia-mater red; substance of brain rather softer than sometimes found; no effusion on the surface, but a very small quantity of clear serum in both lateral ventricles.

No. 292.—The same terrier dog that had the spirit of wine twenty-four hours before, (No. 262,) evidently suffering from its effects, and had been all day, had one drachm of chloroform given upon a sponge, at a temperature of 65°. He made comparatively little resistance; in one minute and a quarter was insensible, and breathed feebly; in two minutes and a quarter he had ceased to breathe, and the heart to pulsate: the sponge was removed, still smelling strongly of chloroform, in two minutes and a half. A good coil-galvanic apparatus, in strong action, was immediately applied, by introducing one wire within the nostril or mouth, and the other within the anus; an incision was also made over the heart, and one wire at times introduced there, (the direction of the current was changed at times, but no difference in the effect was observed;) at first, convulsive action was produced over the whole of the muscles; this, however, gradually declined, and by fourteen minutes had entirely ceased; and though the wires were applied until fifteen minutes, no effect was produced,—neither respiration nor action of the heart were excited.

Post-mortem examination immediately galvanism ceased to produce any effect.—Chest: heart flaccid and uncontracted; all the cavities full, venæ cavæ full, pulmonary veins full, but not excessively distended; the aorta and pulmonary artery full; blood dark and fluid, alike in both sides of heart. Lungs much engorged; the upper

lobes scarlet, the lower nearly black; no effusion in the pleuræ. Lining membrane of the larynx and trachea injected and inflamed, and covered with a considerable effusion of plastic lymph; stomach well filled with food, but the lining membrane very red and vascular. Head: no effusion upon the surface; all the vessels, both of the dura and pia-mater, excessively filled with black blood, as were the vessels of the brain itself; no effusion in the ventricles. Blood of a dark dirty red,—nearly black when seen in mass; no change in its character under the microscope, as observed immediately: muscles quite rigid in half an hour. Twenty-four hours after; heart still soft and distended, blood partially coagulated, alike black in *all* the cavities of the heart, and in the vessels of the head.

No. 293.—A small adult cat was put into a six-hundred-cubic-inch jar, with thirty-five minims of chloroform upon paper, at a temperature of 65°. There was no uneasiness, she gradually fell asleep, and sank down insensible, which she was in five minutes; she continued to breathe until seven minutes and a half, and was taken out before eight minutes, and immediately subjected to the influence of the galvanic battery, the action of which was most intense and life-like, her appearance simulating a perfect fury; even some noise was produced in the larynx by the violent contraction of the muscles of expiration, and the contents of the rectum were expelled. There was, however, nothing like an effort at inspiration, and the action gradually ceased; in ten minutes there was very little contraction, and none in fifteen minutes. She was perfectly rigid within half an hour of the *commencement* of the experiment. The galvanic stream was interrupted, and applied, as in the dogs, from mouth to anus, and vagina, and through incisions on each side of the chest. Blood immediately taken, under the microscope had a natural appearance.

Post-mortem examination twenty-four hours after death.—Head: sinuses not filled; vessels of pia-mater a little congested; brain natural, but perhaps rather vascular; a trace of clear effusion in the ventricles, none upon the surface. Chest: no effusion in the pleuræ; lungs scarlet in colour; pulmonary veins containing very little blood; lining bronchial membrane rather injected. Heart distended and flaccid; a little pericardial effusion; all the cavities filled with blood, partially coagulated; in the left auricle and ventricle it was perfectly black, in the right ventricle of a

dark brick-red colour, and in the right auricle the coagulum was nearly colourless fibrine; aorta, pulmonary artery, and venæ cavæ especially the latter, filled with black blood.

No. 294.—A half-grown cat was put into a two-hundred-and-forty-cubic-inch jar, with thirty minims of chloroform. She was kept in three minutes and a-half, until fully under the influence of it, and taken out without consciousness, sensation, or reflex action, and immediately put into a two-hundred-cubic-inch jar of pure oxygen. She remained doubled up in a lump, just as pushed into the jar, without the least motion, except very faint respiration for twenty minutes. When taken out, she was exactly in the same condition as when put in, but immediately improved. In one minute there was reflex action; in four minutes there was some sensation and a little motion; in eight minutes she was able to crawl, and soon became well, except weakness.

No. 295.—Two young cats, about three-quarters grown, of exactly the same size, were put together in the six-hundred-cubic-inch jar, with forty minims of chloroform. They were kept in eight minutes, being affected exactly to the same degree; they had neither consciousness, sensation, nor reflex action, but respiration continued tolerably good. The one was immediately put into a two-hundred-cubic-inch jar of oxygen, the other was laid upon the table; the one in oxygen was kept in a quarter of an hour, during the whole of which time, with the exception of breathing, it continued perfectly motionless. When taken out she was insensible, but immediately began to improve, and in a very short time was conscious; in five minutes she was able to walk, staggeringly, about the room, the heart beating with such extreme feebleness as scarcely to be felt. The one that was laid upon the table was not touched; she soon breathed freely, and there was some convulsive movement about the neck and eyes. In ten minutes she moved one of her feet a little, and in twelve minutes, when her toes were pinched, she started up and rolled over, quite sensible and conscious, but confused. She was able to walk sooner than the corresponding one that had been in oxygen; her heart beat more powerfully, and at the expiration of an hour she appeared much stronger and more vigorous than that. The contrast in the power of the heart's action was much in favour of that to which nothing was done, as well in a quarter of an hour as in an hour.

No. 296.—A four-months'-old dog was put into a six-hundred-cubic-inch jar, with forty minims of chloroform, and kept in eight minutes. When taken out he was insensible, and the muscles were flaccid, but he was not so thoroughly under the influence of the chloroform as is often seen, the respiration being regular and vigorous. He was instantly put into a four-hundred-and-fifty-cubic-inch jar, containing a mixture, in equal proportions, of oxygen and atmospheric air. At first he breathed well, and continued to respire for six minutes, the respiration, however, gradually becoming weaker: he was kept in ten minutes, but during the last four he had not breathed, and when taken out was quite dead.

Post-mortem examination twenty-four hours after death.—Chest: there was considerable clear serous infiltration along the course of the superior cava, from the place where the jugular vein had been opened in a former operation, down to the heart; the lungs were dark red in colour, soft in structure, and so engorged with serum, as scarcely to collapse at all, and felt almost solid; the muscular structure of the heart was firmly contracted, but all its cavities contained solid black coagulum, as did the venæ cavæ and pulmonary vessels. Head: the sinuses of the dura-mater were filled with black coagula; the vessels of the pia-mater, both upon the surface and within the ventricles of the brain, were filled; the brain itself was studded with bloody spots when cut, and serum escaped from the cut surfaces as though it were œdematous.

This dog had, some days before, had the neck opened for the purpose of injecting an anæsthetic into the internal jugular vein, but in consequence of some mismanagement as the injection was made into the vein, some little passed along the sheath; hence these appearances, several of which are, I believe, rather to be attributed to this than to the inhalation.

No. 297.—A three-quarter-grown cat was placed in a six-hundred-cubic-inch jar, containing thirty minims of chloroform, two hundred and fifty cubic inches of pure oxygen, and two hundred atmospheric air. She immediately began to slaver, and in one minute was unable to stand; she continued struggling with her fore feet until two minutes and a-half, when she had become wholly motionless, except that she respired by the

diaphragm pretty regularly up to fifteen minutes, when respiration appeared to cease, but in one minute returned spasmodically, and so continued intermittingly up to twenty minutes, when appearing dead, she was removed. No motion of the heart could be felt, but in the course of one minute the heart acted, and diaphragmatic respiration went feebly on. Even at ten minutes the heart beat with so little power, as scarcely to propel any blood; no pulsation could be felt in the carotid, axillary, or femoral arteries, but the faintest motion could just be perceived in the external iliacs. At eighteen minutes after being taken out, there was the faintest reflex action, and in twenty minutes she was just able to stir her limbs. Up to twenty-two minutes, the respiration had been entirely diaphragmatic, she then took an inspiration by the ribs. Muscular power gradually returned, and in half an hour, when put up, she could rest on her belly without falling over, but could not sit or crawl until forty-five minutes.

No. 298.—Two cats, of exactly the same size, were placed in a six-hundred-cubic-inch jar, with one drachm and a-half of sulphuric ether. As at nine minutes, though somewhat affected, they still moved about, forty minims more were added: both of them became insensible and unconscious, but still continued to breathe freely, when, at fifteen minutes, they were taken out. One was immediately put into a four-hundred-and-fifty-cubic-inch jar of pure oxygen, and the other was laid upon the table. This one immediately moved, and in the course of a minute perceived pressure; in two minutes was able to roll over, and in three minutes to crawl. The one in oxygen did not move for two minutes; in three minutes she raised her head a little, and at five minutes, when taken out, she was just able to stand, but was weaker in every respect than her companion cat, and the heart was beating with excessive rapidity, 200 per minute; the other cat's, at the same time, 150.

No. 299.—Two other similar cats were placed in the same jar, with two drachms of sulphuric ether, and kept in fifteen minutes. One of them was put immediately into a four-hundred-and-fifty-cubic-inch jar of oxygen, and the other was laid upon the table. The latter was almost immediately sensible, and able to walk; the other lay perfectly still, in the same condition as when put in, until eight minutes, when, on a lighted taper being

put in to ascertain the condition of the oxygen, the taper made a bright flame. This roused her up as if from sleep, but it was two minutes more before she was able to stand; she then became much distressed, and was taken out at ten minutes, able to stand, but not nearly so strong or lively as the cat to which nothing was done.

In the experiment above, No. 298, the cat which was most violently affected, if there were any decided difference, was that which was *not* put into the oxygen, while in the last it was reversed; and that which appeared to be most affected *was* put into it, so as to contrast, and yet to equalize as far as possible, the experiments.

LOCAL ACTION.

The local action of all the agents tried, whether applied in the fluid state or in vapour, is to induce redness, some tumefaction, and paralysis, with loss of feeling of the part which has been exposed to their influence. Chloroform and the chloride of olefiant gas possess this property in the most marked degree; some of the ethers, as the nitric and hydrochloric, in the least. The limb may be cut, torn, or amputated, without any perception, though the animal is perfectly conscious, and possesses sensation in its other limbs, as usual, if the limb experimented upon has not been too long exposed. If the hind leg of a frog, for instance, be exposed to the vapour of chloroform for one minute, or be merely immersed for an instant in the fluid, it becomes red, (more especially from the vapour,) and is without sensation or power; if the exposure be more prolonged, the other hind limb loses its motion and sensation; and if still more prolonged, then the whole body participates in the condition. The fore limbs may be similarly affected in succession, but this is more difficult to accomplish, as it is hardly possible to prevent some of the vapour being inhaled at the same time that the fore limb is exposed to the action of the agent. If a newt or a frog be put into water, to which chloroform, sulphuric ether, or the oil of wine, has been added, they are affected very much sooner with the first than with the latter. In fact, with all these agents, allowance being made for their different

solubility, the relative intensity of their effects is pretty nearly the same in water as in air.

No. 300.—The left hind leg of a very large frog was put into an ounce and a half phial, into which half a drachm of *acetic ether* had been put. The thigh was put in up to the pelvis, and exactly fitted the mouth of the bottle, so as to prevent evaporation, while the toes touched the ether. The phial was occasionally moved about, to allow the ether to flow over the skin. At first, he struggled to escape, but soon became perfectly quiet. The limb was kept in the bottle five minutes. When taken out, the leg was perfectly stiff and motionless, but he was active and vigorous, moving off with the three other legs fast enough, while the left was dragged useless and still. Gradually the right hind leg became senseless and with very little motion, and in five minutes he had become altogether dull, and disinclined to stir. He lay for an hour with the left leg perfectly useless, and without any sensation; he could move the other three a little, but could not crawl. When put into water, he was somewhat roused up. The following day the colour of the skin was altered, and the whole limb was swelled, with little power of motion; it was tender and vascular. He recovered after three days.

No. 301.—A very large frog was treated as the last, with one drachm of sulphuric ether. It was kept in for five minutes. When taken out, the limb was apparently insensible, and was much weakened, but still motion was not altogether destroyed; he could jump some inches at a leap. He soon recovered sufficiently well to leap off the table.

No. 302.—The left hind leg of a rather smaller frog was placed in a similar manner in a phial, with fifteen minims of chloroform. For two minutes it struggled hard to escape, then became perfectly still. When removed, at the expiration of five minutes, it jumped away, with the leg standing out perfectly rigid and motionless. This was then cut off in four successive portions, without the least indication of sensation. There was not any motion, nor attempt to escape; not even a motion of the eyes, which, in frogs, is perceived at once on the least approach of danger; while, if the body or other limbs were pricked, he moved away quickly enough. Within two minutes afterwards he suddenly took a leap, and in so doing moved the stump by the pelvic

muscles, which had not been immersed. Soon afterwards he roused up, when the stump bled, the blood being of a bright red colour. Put into water, but soon died.

In these three experiments, the fluids were made to come in contact with the skin.

No. 303.—The left hind leg of a very large toad was put into a phial, but not so as to touch the fluid, into which half a drachm of chloroform had been put. At first, like them all, he struggled, as in pain, but soon became quiet. There was a copious effusion of thick white cohesive fluid from the cutaneous glands. When removed, at eight minutes, the entire limb was perfectly rigid and insensible; he crawled away upon the other three, with this projecting behind. After three minutes, the left fore leg was put into the phial: in five minutes it had become perfectly useless, the right fore leg being active, so that he was paralysed upon the left side, both as regards motion and sensation, while the right limbs were in a normal condition. After a few minutes he could move the left limbs, and soon recovered, to some extent, but the next day was dead.

No. 304.—A large frog was treated in a similar manner. When taken out, in eight minutes, the limb was in a like condition, rigid and senseless, the frog crawling about the table upon the other three. After three minutes, the left fore leg was put in: within five minutes it was perfectly insensible, though it still possessed the faintest power of motion; but now the right leg had become, without any exposure to the chloroform, quite useless. He became dull and inactive, and died during the night.

No. 305.—A large frog, similarly treated, with forty minims of sulphuric ether, but kept in ten minutes. When taken out, he could not move *either* of the hind legs; the fore legs he could, but was not able to crawl. When the nostrils or eyes were irritated, he put the fore leg over the head, and tried to rub the probe away. The left leg, which was exposed to the vapour of the ether, was quite insensible, as well as motionless; the right, though motionless, was not altogether insensible. On one of the fore legs being exposed to the vapour for five minutes, it became stiff and insensible. The frog died during the night.

No. 306.—The left hind leg of another large frog was in like manner exposed during eight minutes to the vapour of half a

drachm of acetic ether. When taken out, not only the limb exposed, but all the others, were perfectly paralysed and *flaccid*. It possessed not the least power of motion, nor apparently of sensation (as it possessed no power of motion, it was of course impossible to be altogether certain of this). The skin of the exposed limb was red, and the vessels injected. In a short time the frog improved, became able to move, and recovered.

In these four experiments, the limbs were not allowed to touch the fluid; they were only exposed to the vapour. The size of the mouth of the phial was such as just to fit the thigh of the creatures up to the pelvis, to prevent evaporation, and yet not evidently to constrict the limb. Temperature, 70° Fahr., in all.

No. 307.—The hind leg of a frog was put into an ounce-and-a-half phial, with half a drachm of oleum æthereum, and kept in for five minutes; during the last three it was perfectly quiet. When taken out the limb was perfectly insensible and powerless, but not so rigid as after chloroform. It was cut off in four successive portions, without any indication of feeling it; the other limbs and the body were sensitive enough, for being pricked he instantly started off. After a few minutes the remaining three limbs became less sensitive; he bled freely, soon recovered, and remained well until destroyed, three days afterwards.

No. 308.—The left hind leg of a very large frog similarly treated, but only kept in for three minutes. When taken out could jump away, using all four legs; the immersed one, however, was decidedly the weakest; when he sprang he always fell towards the left side. Limb cut off in three portions; no sensation at the lower part; a little at the upper; bled freely. There was not the least general affection; he was as vigorous and lively as ever, and lived many days, indeed, until destroyed.

No. 309.—A small and not very vigorous frog: the hind leg was kept in the phial with the oleum æthereum for three minutes. When taken out the animal was dull, and there was very little sensation in any of the limbs, though reflex action was good. Soon recovered.

No. 310.—Experiment repeated for three minutes, upon a small but more vigorous frog. When taken out he jumped off with the immersed limb perfectly insensible, but not devoid of all motion,

though this appeared to arise rather from action of the muscles of the hip joint than of those of the leg which had been immersed. The limb was cut off in four successive portions, without the least indication of sensation; the other limbs were quite vigorous and sensitive. Recovered.

No. 311.—A small frog had both hind legs put into the phial, but so as not to come within two inches of the fluid. It was removed at five minutes with them red, perfectly senseless, and paralysed; there was also but little power in the fore legs, though respiration was good. Next morning perfectly well.

No. 312.—A strong frog, whose hind leg had been subjected to the local action of chloroform, and amputated above the knee without sensation, (which, however, was perfectly acute in the other legs,) was lying dull, inactive, and flaccid. It was put into a jar with a few drops of oleum æthereum, when it *instantly* roused up, and jumped most vigorously about for one minute and a half, the fluid acting as a most decided stimulant. It afterwards became dull, and was kept in until it died. The amputated stump was most rigid and motionless, while its muscles were so contracted as to leave a long portion of the bone bare; but all the other limbs became as flaccid as possible. When the portions were first cut off the limb, there was scarcely any hæmorrhage, nor afterwards until put into the oleum æthereum, when the stump bled very freely.

No. 313.—The hind leg of a very vigorous and active frog was put into a phial, with half a drachm of nitric ether, for five minutes. It was removed with this nearly motionless; indeed, except at the hip joint, altogether so, and it was quite insensible. The animal was as vigorous as ever, and leapt so actively, but without using the left limb at all, as to make it difficult to catch it. In three hours the limb was as still and insensible as at first, but the creature was much less active; it could leap, but was not so ready to do it, and then leapt to a much less distance. The next day the limb was perfectly paralysed, though rather red and swelled. In three days it was well, but somewhat discoloured.

No. 314.—Experiment repeated on another frog. The limb, on being taken out, was cut off in six successive portions, without any feeling. The boundary of the affected part was well marked. To the upper part of the thigh no notice of the skin or muscles

being cut was taken; but the instant the skin near to the coccyx was seized, it directly called out and jumped away. The animal soon became perfectly well, and remained so.

No. 315.—A small frog had both hind extremities, up to the pelvis, put into the phial for one minute. They were both nearly motionless; at the lower part they could be amputated without sensation, but there was some feeling in the thighs. It died.

No. 316.—The lower half, up to the middle of the back, of a small frog, was put into the phial for a minute and a half. When removed the extremities were insensible and motionless, and the creature was altogether dull. It soon died, without rallying. The colour of the skin was less changed from the action of nitric ether than with the other agents; but the ether itself became of a yellow tinge.

No. 317.—The hind leg of a frog was put into a phial, with half a drachm of bisulphuret of carbon. It made most violent efforts to escape, and the leg soon became covered with white mucus. When removed at five minutes, it jumped away quite vigorously. Though the limb was much weakened, motion was not altogether lost, neither was sensation; for though it was cut off in three portions without much evidence of sensation, yet there was not that total absence of all indication of consciousness of anything being done, which was evinced with the other agents. The stump bled freely; blood red. In half an hour it could move the stump, and seemed quite well. The limb was not so red, nor so much swelled, with the bisulphuret of carbon as after the application of chloroform or sulphuric ether.

No. 318.—Six frogs, which had been subjected to the local action of oleum æthereum, and their limbs amputated, were lying in a large jar, apparently nearly dead, only just breathing, when five drops of bisulphuret of carbon were put into it: they *instantly* started up, and jumped rapidly about, with great force, for a minute, when they became perfectly quiet, and were not observed to stir afterwards.

No. 319.—The hind limb of a large frog was put into a phial, containing twenty minims of Dutch liquid. It, like all the others, struggled much to escape at first. It was kept in ten minutes; when taken out, the animal was altogether nearly motionless and flaccid, except the immersed limb, which projected out, perfectly stiff. After lying for half an hour, the frog

became lively and moved about, with the limb as rigid and insensible as a piece of wood. It could not jump, in consequence of the muscles of the back being so affected, that this stood out at quite an angle. The experiment was repeated upon a small frog, in which both the hind legs were immersed, and rendered senseless in three minutes; also upon two toads and four newts. Two of the latter had the head and fore legs immersed for one minute and a-half, two the tail and hind legs. The respective parts were rendered still and motionless; the other parts retained their power of motion.

In making these experiments, it is of importance not to continue the contact of either the vapour or liquid too long, or the whole body becomes affected, or the animal dies after rallying for a time.

No. 319*.—A large frog and a large newt were placed in a sixty-cubic-inch jar, with eight minims of Dutch liquid. In seven minutes the newt was to all appearance dead, and in eighteen the frog appeared so; but in twenty minutes, after being taken out, they could move, and the next morning were perfectly well.

No. 320.—Experiments repeated, with similar quantities of the chloride of carbon, with like results, the only difference being that a minute or two longer is required to produce the same result. These creatures were, with the exception of the newts, well the next day. The immersed limb of the frog was swelled and insensible, but not so rigid.

No. 321.—Experiments repeated with hydrobromic ether. The effects are similar, but a larger quantity of the fluid and a longer time are required to produce insensibility, and the animals or limbs do not become so rigid. Sometimes the immersed limb continues perfectly flaccid. They will, however, recover from apparent death.

No. 322.—Experiments repeated with hydriodic ether. This acts more powerfully than hydrobromic, but it is far more destructive. The animals all died, as well after a very short immersion as from inhalation of a few drops.

Hydrochloric ether, when applied locally, does not act so powerfully as the other ethers. When inhaled its action upon these animals is rapid and, apparently, destructive; but they will sometimes slowly recover after seeming death.

No. 323.—Experiments repeated with benzole. When the fluid is applied to the skin it evidently produces considerable pain; the immersed part soon becomes very red and swollen. When taken out in twelve minutes, the frog could jump upon the other three legs, but in a short time it became quiet and dull. The frog and newt placed in a sixty-cubic-inch jar, with seven minims of benzole, were taken out in twenty minutes, apparently dead; but after five minutes, on the frog being touched, its limbs moved, as though electric shocks were passed through them; these increased in frequency and violence; the least touch constantly reproduced the starting; then they came on without external stimulus, and after an hour motive power and reflex action were re-established. On being put into water these twitchings were, for two minutes, incessant. The amputated leg bled very freely. The next day all these animals were well.

No. 324.—Experiments with naphtha. This evidently gives pain; it produces anæsthesia, both when inhaled and applied locally, but more is required than of most of the other substances used, and it is destructive. Coal naphtha is more powerful and more destructive than potassium naphtha. Mucus is freely effused from the surface. Temperature of the room in the last six experiments 60°.

No. 325.—The cockroach, (*Blatta orientalis,*) and the slow-legged beetle, (*Blaps lethifera,*) are very soon affected by either the direct application, or the vapour of, chloroform, less so by that of acetic ether, and much less by that of sulphuric ether. Chloroform is almost instantly fatal; so is acetic ether, if they are immersed in it; but sulphuric ether is borne for half a minute, and, if not too long continued, they recover their activity. Oleum æthereum acts more powerfully, but is not more destructive than sulphuric ether. They may be locally and partially paralysed: by making the application to the hind part of the body or to the base of the posterior legs; these become powerless, while the anterior legs move; but if the application be made to the head, then the fore legs are paralysed, while the hind continue active for some little time after the fore are still.

These experiments I have repeated with the chloride and the bromide of olefiant gas; hydriodic and hydrobromic ethers; with bromoform, with benzole, and with the three varieties of naphtha.

The insects have been placed in jars, and the agents dropped in, so that only the vapour has been inhaled, and the fluids have been directly applied to the anterior or posterior portion of the body; however varied, the general result has been the same. In activity the fluids appear to act pretty much in the same ratio upon these creatures as upon the higher, and the poisonous effects are nearly the same. Hydriodic ether, the bromide of olefiant gas, and bromoform are soon fatal. Hydrobromic ether they recover from, if the dose be not too large, as also they do from benzole, though this appears to affect them powerfully. In one instance, after applying a minute drop of the chloride of olefiant gas to the head of a cockroach, it appeared dead for several hours, but subsequently recovered. They also will recover, after apparent death, from sulphuric ether or the oil of wine, but not equally so after chloroform.

No. 326.—The right hind foot of a rabbit, five weeks old, was placed in an ounce jar, the mouth of which just received it, thirty minims of chloroform having been put into the jar. This was directly absorbed by the hair.* The rabbit immediately struggled hard to get away; this was repeated two or three times up to five minutes (I was not perfectly sure if the struggles were entirely voluntary or not,) after which it remained very quiet, without attempting to get the foot out of the jar. It was sleepy, but perfectly conscious. The foot was taken out at fifteen minutes. It could be moved, but appeared much weaker than the others. I cut off in succession, with scissors, three of the toes, without there being the least movement, or any indication of sensation, whereas lively indication of pain was directly manifested on the other limbs being pinched, or even if this leg was touched above the heel. In half an hour sensation had, to some extent, returned, but the limb was still partially paralysed. It was hotter than the others, and the integument was swelled. In twenty hours the sensation, motion, and temperature were the same as in the other limbs.

No. 327.—Experiment repeated upon another rabbit, forty

* The great quantity of chloroform which is absorbed by hair, or any fibrous material, is worthy of notice. A portion of lint will absorb an amazing quantity without feeling wet; it almost appears to become incorporated with it. A quarter of the quantity of water would completely saturate the lint, and drop from it.

minims of chloroform being used. It immediately cried and struggled hard, but after two minutes it did not cry. It for the most part lay quite still, though moving occasionally. The limb was removed at the end of forty minutes; it was nearly, but not completely, paralysed, and sensation was to a great extent, though not entirely lost; about the toes there was none whatever; at the heel there still was some. The foot was returned to the jar, and kept in until the expiration of the hour: when removed, the rabbit was disposed to lie asleep, and was unwilling to move. Each of the toes was in succession cut off, and then the entire foot immediately below the ancle joint; during which operation the creature lay in the most perfectly quiescent state imaginable. It was not held, nor did it move or give any indication of feeling, but the moment the leg above the ancle joint was pricked, (where the chloroform had not reached,) it started up, as it also did when any of the other three legs were pricked. Destroyed by a blow behind the head.

No. 328.—The right hind foot of a strong male kitten was put into an ounce jar, with forty minims of chloroform. In half an hour the sensibility was greatly diminished, but not entirely lost, and he began to be very sleepy: the foot was kept in for an hour. For part of the time he was very sleepy, and lay perfectly still: he then struggled hard, and tried to bite. Just before the foot was removed, he passed water in a very forcible stream, and at the end several drops of blood came from the urethra, the penis being considerably protruded. The limb was perfectly paralysed; he dragged it uselessly after him, turning round and rolling over from side to side. Sensation was not completely destroyed; considerable pressure could be borne, as could pricking and a slight cut; but when a more decided incision was made, there was indication of feeling. The foot was rather swelled. In half an hour sensation had, to a great extent, returned; and motive power was also increasing, but there was also more tumefaction. At nine hours after the foot was cool, and the swelling gone. There was considerably more power in motion, but still the limb was not used in walking. The next day quite well and natural.

No. 329.—The hind leg of a three-months'-old cat was put into a two-ounce jar, with forty minims of chloroform. It struggled

hard, and cried much for a long time, but at the end of an hour it had become perfectly quiet and still. The limb was swelled, and almost useless, but not entirely without sensation. Thirty minims more chloroform were put into the jar, and the leg returned to it for another half hour. It was now as nearly as possible paralysed and insensible. One toe was cut off without any indication of feeling: when a second was removed, there was a very slight movement. The foot immediately below the os calcis was then amputated, afterwards all the soft parts, the nerves and blood vessels, in fact, everything but the mere bones of the leg above the ancle joint, were then cut through. There certainly was some little indication of perception, but so little was the feeling that, though the limb was not held, the cat did not make any effort to get away. It bled freely; blood natural in colour. Killed.

No. 330.—The left hind leg of a kitten was put into a similar jar, with forty minims of acetic ether, and kept in for half an hour, without any very decided effect being produced. Sensation was somewhat diminished, but motion was as good as ever.

No. 331.—The hind leg of a kitten, eighteen days old, similarly treated, with forty minims of nitric ether. It immediately cried out, and struggled much; it continued to do so until removed, at half an hour. It was somewhat, but not materially affected; it could both move it, and had sensation. One minim of chloroform was put upon the nose; it was instantly affected, and made most violent attempts to escape; in ten minutes it appeared to be dying. It remained perfectly still until left for the night, and the next morning it was lying fast asleep in the exact place and position in which it had been left; but on being handled it roused up, and with the exception of the respiration being quick and feeble, it was soon as well as ever.

No. 332.—The hind foot of a five-weeks'-old rabbit was similarly treated, with forty minims of sulphuric ether. It was kept in for twenty minutes; at first (like No. 327,) it struggled and cried, but not to the same extent, and during the latter part of the time it was perfectly easy and quiet, though quite sensible. On being taken out, three toes were successively cut off without the least indication of its perceiving the removals, though sensation was as acute as ever in the other limbs, and

in this above the place to which the mouth of the jar had reached. The limb was not paralysed, though less active than the other leg. The rabbit went jumping about the room. In an hour the limb was swelled and hot, and when placed in any position it was disposed to remain in it, but it could be moved without any apparent difficulty.

No. 333.—The hind leg of a three-months'-old kitten was put into a two-ounce-and-a-half jar, with forty minims of oleum æthereum. It continued to struggle and to cry at intervals for an hour, as though in pain, when the leg was removed. Sensation was good; in fact, the skin was tender. Thirty minims more were put into the jar, and the leg returned to it for half an hour more: when taken out the cat was quite lively, the limb was swelled, there was very little motive power remaining, but sensation was by no means obliterated. It could run about on three legs, but constantly lay down, seemingly being easy and sleepy. The immersed leg soon became hot and tender.

No. 334.—The hind leg of a six-weeks'-old rabbit was put into a two-ounce-and-a-half jar, with one drachm of oleum æthereum. The jar was sufficiently deep to receive the leg quite up to the thigh. It was kept in for twenty-five minutes: when taken out the rabbit appeared dull, but was quite sensible, and with sensation perfectly good in every other part. The immersed limb was altogether useless and senseless; the skin was red. All the toes were in succession cut off; then the foot was amputated, without the least indication of any sensation whatever, or of any consciousness of anything being done to it. The limb was then removed through the ancle joint: at the moment the knife pierced the skin, the animal gave a little movement. The leg was then amputated nearly as high up as the fluid had reached. Here there was some little motion of the limb, and certainly some trifling sensation, but not sufficient to cause the rabbit to make any attempt to get away. It was immediately roused by a prick in any other part. Killed by a blow.

No. 335.—The hind leg of a five-weeks'-old rabbit was put into an ounce jar, with twenty minims of chloride of olefiant gas, and kept in half an hour. It struggled for a few minutes, then lay still, as though asleep, until fifteen minutes, when it started up, and cried out. It soon became, and remained, still

and sleepy until taken out; it was then with some difficulty roused; when it awoke it cried, and was confused. The toes were swelled and red; they could hardly be moved. After waiting for five minutes, until the general effect had gone off, the four toes were cut off in succession, without the least indication of sensation. On any other part of the body being pricked, the creature was sensitive enough. Not a drop of blood escaped. This being the last of the fluid I then had by me, I could only immerse the toes, and not the foot.

No. 336.—A fellow rabbit to the last had the hind foot placed in a similar jar, with half a drachm of hydriodic ether, and kept in during half an hour. Like the last, it once or twice cried out as though in pain, and when taken out, the foot was red and swollen. There was no general effect; it hopped quickly about on three legs, the one that had been immersed standing stiffly out behind. It was motionless and senseless, all the toes and a portion of the skin of the foot being cut off in succession, the creature lying upon my knees still and uncontrolled. Not a drop of blood appeared.

No. 337.—A fellow rabbit had the hind foot put in a similar manner into one drachm of hydrochloric ether, and kept in forty minutes. It was neither swollen, red, motionless, nor without sensation.

No. 338.—A fellow rabbit had the foot in like manner put into half a drachm of benzole, and kept in forty minutes. Sensation was blunted, but not destroyed; and though weak, the leg could be moved.

No. 339.—The hind foot of a rabbit was put into an ounce jar, with forty minims of bisulphuret of carbon. It immediately cried out loudly, and made great attempts to escape, as though in considerable pain After two minutes, it lay perfectly still and easy until fifteen minutes, when it again struggled hard, apparently being excited by hearing another rabbit move about the room. It was then still until thirty minutes, when it again struggled violently, and cried loudly; it for the most part then lay still, with occasional moanings, until taken out, at the end of an hour. There was no general affection, the limb had very little power, and it hopped about the room on three legs, and the limb remained in whatever position it was placed in. Near

to the heel there was some sensation, but none whatever at the toes. One of these was cut off in two portions, the web between the others, and the pad at the sole of the foot, were pierced without any manifestation of feeling. Seven hours after the whole limb was soft, swelled, hot, and tender; it could be moved, but in jumping about it was not used. The creature was lively and cheerful, but the next day died: whether from the application is doubtful, as another, which had not been subjected to it, was also dead.

No. 340.—The hind leg of a strong three-months'-old kitten was put into a two-ounce jar, with one drachm of bisulphuret of carbon. During the whole hour it was kept in, it struggled hard, and made great attempts to get away; it appeared pained. When removed the limb was, to a great extent, useless; it was swelled and hot; sensation was not destroyed, though blunted: there was no general affection. The next day the limb was much swelled, and very tender; it could not be used from the inflammation, which was very intense, and continued several days, the kitten appearing to suffer considerably. Every particle of the hair of the part which had been immersed came off, and the skin was very sore. The inflammation after several days subsided, and the integument became shrivelled and dry. The use of the limb returned, and the kitten became as active and lively as ever; but there was no indication of the reproduction of the hair when the kitten was used a month afterwards for another experiment.

No. 341.—One drachm of sulphuric ether was put into an ounce jar, the mouth of this being of just sufficient width to admit and fit round the upper part of the little finger, which was placed in the jar, and there retained for one hour. The whole finger was kept constantly wet with the ether by frequently agitating the jar. For some time but little unusual sensation was produced; however, the finger gradually became warm and somewhat swollen, with a numb tickling sensation. This gradually extended up the fore arm to the upper arm, and was particularly felt along the ulnar nerve above the elbow. A prick or sharp pinch at the end of the finger was not felt; the sensation was much more decided an hour after the finger was withdrawn from the ether than at the moment of withdrawal. The skin became dry, and the finger stiff and extended, and required considerable effort to move it: when touched the sensation was exactly as after a nerve has been rather severely

pressed. This feeling continued with little change for three hours, up to my going to bed. In the morning it felt more natural; it was still stiff and very numb, but in the course of the day the feeling much increased, and now, twenty-seven hours after the immersion, the finger is hot, numb, and requires very considerable effort to move it. There is a constant sense of heat and aching along the anterior ulnar edge of the fore arm, and up the inner side of the arm, as far as the insertion of the pectoralis major muscle. The feeling of stiffness in the finger is so decided, and the want of command over it so great, that I dare not put that of the right hand in chloroform to night, as I had intended, lest to-morrow it should be in the same state, and thus disable me, (as it certainly would,) from operating for cataract, of which I have two cases.

The next morning the sensation had not entirely subsided; a prick could be perceived, but the finger did not recover its usual condition until forty-eight hours had elapsed.

No. 342.—Ten days afterwards the finger was immersed in a similar manner in a drachm of chloroform. There was more pain at first, with more redness, and the heat and swelling were somewhat greater than after the ether, and certainly the loss of sensation was also more decided. It was not until sixty hours had elapsed that all unnatural sensation had passed away.

No. 343.—Finger in a similar manner placed in a jar, with one drachm of oleum æthereum. In three minutes it began to feel warm, and in ten to smart. It was kept in the jar for an hour and a half: at times the smarting amounted to decided pain, and the sensation of heat was considerable. When taken out it was hot, stiff, and could only be moved with difficulty; sensation was deadened, but not destroyed. The next morning the skin of the finger was shrivelled, and subsequently the cuticle partially desquamated; at the upper part, just to where the oleum vini had reached, it was inflamed and tender; the whole finger was numb, and some little feeling of numbness extended along the ulnar side of the fore-arm to above the elbow. In the evening, (twenty-four hours after the immersion,) the inflammation and pain had entirely disappeared, but not the numbness of the finger or arm, which did not entirely pass off until the next evening.

No. 344.—The finger in like manner was immersed, for one

hour and a half, in acetic ether. A feeling of coldness rather than of heat was experienced, though at times there was heat. There was a little loss of feeling, but only slight, and the next morning the finger was in every respect the same as the others. This experiment was repeated with the same result.

No. 345.—The little finger was placed in a similar jar, with thirty minims of chloride of olefiant gas, and kept in an hour. The heat and smarting were at times very considerable, especially at the mouth of the jar. The finger was not so red as with chloroform, but the numbness and stiffness were greater. For three days there was very little use in it, and it was not until the sixth that sensation and motion were quite natural. It is curious that these feelings were intermittent and more decided each evening. The numbness extended to the *ulnar* side of the ring finger, but not to the radial side.

No. 346.—A young man, (a collier,) whose eyes had been destroyed by a blast of gunpowder three years before, and who had been more than once operated upon by different persons for artificial pupil, was again desirous to undergo the operation, though there was hardly any rational hope of success. Thirty minims of chloroform were put into a jar, the mouth of which exactly fitted to the orbit, to which it was retained for twenty minutes. At first he complained of considerable smarting and heat; the conjunctiva became much congested, and the skin of the eyelids red; but the smarting entirely subsided, and the operation was performed with little suffering; indeed, it was comparatively little felt. Immediately afterwards the man fell asleep, and continued so for several hours. The eye the following day was vascular, but the section of the cornea healed immediately, and he recovered from the effects of the operation as rapidly as possible. I had operated upon the same eye some months before; he then complained of intense pain, and was very unmanageable. This time he scarcely made any complaint, and was perfectly still; indeed, it was evident to those present that he did not feel the operation much.*

* As an evidence of the patient's opinion of the effect of this local application, I may mention that the day I received this sheet from the printer this young man had returned, again desirous for an operation, though utterly useless, and of his own accord asked for "some of the stuff to be put to the eye, that he might not feel the pain." He positively refused to inhale it.

No. 347.—Mr. ——, a middle-aged man, who had had destructive inflammation of the ball of the eye, which had ended in hydrophthalmia and staphyloma, which produced considerable inconvenience by protruding the palpebræ, and causing so much irritation as to interfere with the vision of the sound eye. I advised the removal of the anterior part of the globe, and fifty minims of chloroform were applied in the same way as in the last case. I had intended it to have been continued for half an hour, but I was detained by another case longer than I had expected, and the application was made for an hour. Like the previous man, he complained of heat and smarting at first; this, however, passed off, though the congestion remained. The whole of the cornea was removed, with a part of the disorganised iris, but still the ball did not collapse; nor did much of the vitreous humour escape. For the moment I was at a loss to account for so unusual an occurrence, but I soon found it to arise from the muscles of the ball being so completely paralysed, that no pressure was exerted upon the ball, and it was three or four days before the collapse was complete, as blood had collected in its interior, and there coagulating, it formed a mass not immediately to be expelled. Not a bad symptom of any kind followed, and within a week the patient returned home, a distance of forty miles. During the operation there was some, but extremely little pain.

No. 348.—Mr. W. had an encysted tumour of the scalp, of the size of a walnut, to be removed. Chloroform was applied in the same manner for forty minutes. Some heat and redness was produced. A section was made through it, and the cyst taken out. The wound healed by the first intention, without a drop of matter being formed. The cuticle desquamated over the space to which the chloroform had been applied. The patient experienced so little pain, that he could not believe the tumour had been removed.

In addition to the substances named in the list of agents whose effects had been tried, I have submitted to investigation two others, the bromide of olefiant gas, and the chloride of carbon, as well as iodide of ethyle, obtained from another chemist; but as they were not received in time to allow of the details being

arranged in their proper places, the experiments with them are here introduced. They will be followed by such observations upon the different substances used as these may appear individually to call for, before replying generally to the questions placed at the commencement of this Essay.

BROMIDE OF OLEFIANT GAS.

HYDROBROMATE OF BROMIDE OF ACETYLE.—(Comp. $C_4H_4B_2$. Sp. gr. 2.164. Boils at 265°.)

No. 349.—A very small six-months'-old bitch, of King Charles's breed, was placed in a six-hundred-cubic-inch jar, temperature 60°, with twelve minims of bromide of olefiant gas. She shortly curled herself round, and lay very sleepy, but without actually falling asleep. At twenty minutes breathing became very laborious; there was some little flow of saliva, with indication of some distress. As these symptoms did not increase, she was removed from the jar in thirty minutes. She was quite able to run about; the heart beat for a short time rather quickly, and there was some sneezing. The bromide was exhausted.

No. 350.—A young, but nearly full-grown, male cat, was placed in a six-hundred-cubic-inch jar, temperature 60°, with twenty minims of bromide of olefiant gas. He immediately became very uneasy, and there was, during the whole time he was kept in the jar, an appearance of great distress; the flow of saliva was very great. He became sleepy, sat still for a few seconds, as though about to fall asleep, then turned and twisted about in all positions; consciousness and sensation were somewhat blunted, but not at all lost. In twenty-five minutes, on being released, he staggered unsteadily for a few steps, and was very cross. The heart could hardly be felt. He was shortly, apparently, as well as ever.

No. 351.—A bitch, of the same age, size, and breed, as No. 349, was placed in a six-hundred-cubic-inch jar, with thirty minims of bromide of olefiant gas; temperature 64°. She immediately lay down, and up to ten minutes appeared quite comfortable and very sleepy; she then became much distressed, with the breathing most laborious. These appearances continued up to twenty-three

minutes, when the respiration became most rapid, and she was all but insensible, though not unconscious. The web of the foot was transfixed three or four times, without her noticing it; but on the nose being punctured she withdrew it. The distress continued, though the loss of sensibility did not increase. At forty minutes, the bromide being all gone, she was released; immediately the distress disappeared, she ran about, and was soon quite active. From a wound in the ear the blood appeared natural; if anything, perhaps, a little brighter in colour. The indication of distress in this and the last experiment were very marked, but in the first there was but little.

These experiments were all made between seven and nine p.m. The dogs were allowed to run about until nearly ten o'clock, when they were put into a stable, up to which time they were active and cheerful, apparently quite well; in fact, No. 349 had to be restrained from teasing the cat. The cat, for an hour afterwards, appeared well; he was then very sick, but soon after went about the house as usual, and at twelve o'clock was observed to have placed himself as usual for the night upon a comfortable chair. To my great surprise, the next morning the cat was found insensible, in convulsions, and died shortly afterwards, about twelve hours after the experiment. The two dogs were both found dead, No. 351 cold and rigid, No. 349 still warm. They were all examined in the evening, twenty-four hours after the experiments had been made. The appearance in the two dogs was not dissimilar; in the cat very different.

Post-mortem examination of No. 351.—Chest: lungs red, but not of a very intense colour, moderately collapsed; pulmonary vessels not much distended; trachea, like other parts, congested, but without mucus. Heart by no means firmly contracted; both right cavities congested, but not at all to the extent of those in the cat; both left cavities also contained blood; venæ cavæ full; aorta contained some blood; in both ventricles there was a little white, soft, pultaceous coagulum, otherwise the blood was all fluid, red in colour, and alike on both sides of the heart. Abdomen: viscera not greatly congested; liver soft; gall bladder moderately full of bile; intestines well filled; bladder contained a little natural urine. Head: sinuses of the dura-mater not very greatly congested, pia-mater moderately so, as was the

substance of the brain; there was a great effusion of clear serum, some upon the surface, the lateral ventricles being filled.

The only difference in the appearance of this dog and No. 351, which had the smaller dose, was, that in the latter the heart was more firmly contracted, especially the left ventricle, which contained but little blood, and that the blood was rather more coagulated than in the first.

In both these dogs the eyes presented an appearance which I never noticed at so early a period after death from any other cause. They appeared white and quite opaque. This I found to be occasioned by a change in the corneæ: these were thickened and quite opaque, just as after immersion for two or three days in water. The other parts of the eyes did not present any change. The eyes of the cat were not so changed; the corneæ were quite clear, and the irides much dilated.

Post-mortem examination of the cat, No. 350.—Muscles, like those of the dogs, quite rigid. Head: sinuses of the dura-mater, vessels of pia-mater, and the substance of the brain all intensely congested; no effusion of serum. Chest: lungs of a bright crimson colour; pulmonary vessels all quite full; trachea congested, but dry; venæ cavæ excessively distended; aorta quite full; both right cavities of the heart excessively distended and flaccid; the left cavities were more contracted, but contained some blood; blood all quite black, and perfectly fluid. Abdomen: viscera all congested; liver soft; gall bladder well filled; rectum and intestines filled; bladder contained some bloody urine.

The globules of the blood in these three animals, as examined under the microscope, did not show anything unnatural.

CHLORIDE OF CARBON.

Comp. C_4Cl_4. Sp. gr. of liquid, 1.552. Boils at 248°. Density of vapour, 5.82.—(*Fownes.*)

No. 352.—A very small four-months'-old dog, ill, from commencing distemper, was placed in a six-hundred-cubic-inch jar, with thirty minims of chloride of carbon, temperature 60°. At first he was still, but soon became restless and uneasy, then dull and sleepy, occasionally barking, until fifteen minutes, when he

was lying helplessly asleep on the side, but he could be roused. Taken out; he persisted in crawling under the fire-grate; he soon was as well as before being put into the jar, and so continued.

No. 353.—A nearly full-grown cat was put into a six-hundred-cubic-inch jar, temperature 60°, with thirty minims of the chloride of carbon. She was rather uneasy but soon fell asleep, and in fifteen minutes was nearly insensible; up to thirty-five minutes she continued fast asleep, and so nearly unconscious that on the foot being severely pressed, though she made some noise, the foot was not withdrawn. The fluid being gone, and the cat being less sleepy, she was removed. She fell, and was unable to crawl for a minute, but gradually improved, and in eight minutes was carefully watching the motions of a young rabbit.

No. 354.—A five-weeks'-old rabbit was placed in a four-hundred-and-fifty-cubic-inch jar, with 20 minims of the chloride of carbon, temperature 60°. It was not uneasy, nor did it become insensible, and though, on being taken out at twenty minutes, able to sit, if touched, it fell upon the side, and there lay. It continued for some time still and sleepy, but in twenty minutes after it was ready to eat food.

No. 355.—Experiment repeated upon a similar rabbit, with thirty minims of the chloride. It was kept in for half-an-hour. It lay perfectly motionless, but on the ear being severely pinched it felt. It was ten minutes after being taken out before it was able to sit. It was soon well.

No. 356.—The same cat as No. 353, forty-eight hours after, was placed in the same six-hundred-cubic-inch jar, with one drachm of the chloride of carbon. At first she was rather restless, but gradually became sleepy, and in seven minutes she was resting against the side of the jar, just capable of being roused. At ten minutes she had sunk by gravity to the bottom of the jar, unconscious and perfectly insensible: she lay so, altogether motionless, except breathing regularly, until fifteen minutes. When taken out, the heart was beating with pretty good power. There was no reflex action until three minutes after being taken out. At first the muscles were perfectly flaccid, but soon tonicity returned, though there was no movement until six minutes, when she got up, and walked staggeringly away for a few steps. At twelve minutes, seeing some milk at a little

distance, she walked to it and eat part. The heart continued to beat jerkingly for a time, otherwise she was well, and so remained. The chloride was not exhausted.

No. 357.—A very strong old male cat was placed in a six-hundred-cubic-inch jar, (temperature, 60°,) with eighty minims of the chloride of carbon. At three minutes he was quietly asleep, and all but insensible, before which he had three or four times struggled so violently as to make me fear he would break the jar. In six minutes he was perfectly unconscious, insensible, and motionless, except respiration. This continued, gradually, however, becoming weaker until twenty-five minutes. At thirty minutes he was taken out dead; pupils greatly dilated. The chloride was not quite exhausted. On being held up by the tail, the contents of the stomach ran out of the mouth in a stream, so thoroughly flaccid were all the muscles.

Post-mortem examination ten minutes after being taken out of the jar.—Chest: lungs of a nutmeg appearance, partly probably from age, and congested; pulmonary veins full; bronchial membrane but little congested; both right cavities of the heart excessively filled; venæ cavæ and all the veins much distended; the left auricle contained some blood; the ventricle quite contracted and empty; pulmonary artery contained blood; the aorta was nearly empty. Abdominal viscera congested; bladder full of urine. Head: sinuses, pia-mater, and the substance of the brain greatly congested; blood all alike, of a dark dirty-red colour. Twelve hours after death, muscles very rigid; right cavities of heart not so full; blood of the appearance of treacle.

In order to ascertain the difference in the effects of the chloride of carbon when inhaled at a considerable elevation of temperature, the two following experiments were made:—

No. 358.—The same cat as No. 353 and 356 was put into the same jar three days after the last experiment, being perfectly well, with forty minims of the chloride, at a temperature of 72°. She immediately began to slaver, but was quiet, gradually becoming sleepy. At thirteen minutes she had sunk to the bottom of the jar, motionless; she was not perfectly unconscious, for on the foot being very severely pressed, she cried out, but did not withdraw it. On a piece of wood being put into the mouth, she bit it savagely. She was kept in until twenty-five minutes, without

becoming more insensible. On removal she could walk, and immediately set to work to clean her skin.

No. 359.—A rather small mongrel dog, about eight months' old, was put into a four-gallon jar, placed so near to the fire as to be of the temperature of 100°, with one drachm of the chloride of carbon. He made no attempt to escape, nor was restless; he did not lose sensation or consciousness, but the breathing became excessively rapid. At twelve minutes, the liquid having disappeared, the cover was removed, and the jar taken away from the fire, as I thought the heat affected him: he immediately breathed better. The pupils were dilated. He sat for two minutes looking vacantly about, then got out, walked away, and rubbed his neck and sides in the manner noticed with several of the animals to whom a moderate dose of chloroform had been given. In ten minutes he was much less active, walked with some difficulty, the hind legs appearing stiff, and lay down with an uneasy look; but he presently rallied, and soon appeared perfectly well. For several days, though he was cheerful and eat well, there appeared to be stiffness in the limbs, as he walked with some effort.

HYDRIODIC ETHER.*

No. 360.—A strong terrier dog was put into a four-gallon jar, with thirty minims of pure hydriodic ether; temperature, 65°. He sat still, without any indication of distress, until thirteen minutes, when the breathing became suddenly most laborious, with mucous râle and mucus collected about the lips; in fact, the air passages appeared choked with it. There was no insensibility. At twenty-five minutes the distress was much less, the

* As notwithstanding the assurance of Messrs. Gale and Co., that the hydriodic ether supplied by them was perfectly pure, I could not feel satisfied that it was not contaminated by phosphorus, and that very possibly the inimical action of it might, in some degree, at least, depend upon the presence of this latter body, I requested Mr. Bullock to prepare me some, which, I have no doubt, is perfectly pure. It is not luminous in the dark, the smell and taste are not so alliacious, and though the general characters remain the same, it is much less unpleasant. Some delay having arisen in my receiving it, the account of the former experiments was printed off before the following were made. I therefore subjoin them now, by which it will be seen that, although my suspicions were quite correct, yet that the effects of hydriodic

ether had disappeared, and on the cover being removed, after two minutes, he got out of the jar without any difficulty. He walked about, and was pleased to be noticed, though he did not appear altogether comfortable, and he was thirsty. When first let out of the jar, his skin felt hot, but very soon became cold, and he crept to the fire: he was restless, and evidently uneasy when left for the night. The next morning he was found dead, cold, and rigid.

Post-mortem examination forty-eight hours after the experiment.—Body rigid; muscles all unusually red, and rather soft. Chest: lungs of an uniform crimson colour, rather collapsed, but solid from mucus in the air cells; there was not any in the trachea or larger bronchial tubes; the pulmonary vessels were much congested; the bronchial membrane was injected, in common with every other part. Heart: all the cavities contained blood; the two right were much distended, as were the venæ cavæ, and, in fact, all the veins. The aorta was full of blood, which in all parts was a dark fluid, like dark, but not very thick, treacle. I never saw the blood more altered in any experiment. Abdomen: all the viscera congested; the liver and kidneys soft; neither the rectum nor bladder were empty, but the gall bladder was nearly so. Head: the sinuses, the vessels of the pia-mater, and the substance of the brain very greatly congested; there was a little serum upon the base and within the ventricles, but no effusion in any of the cavities; nor was there anything like the consolidation from pneumonia.

No. 361.—A large old cat was placed in a six-hundred-cubic-inch jar, (temperature, 60°,) with twenty minims of hydriodic ether. At first saliva flowed, and she was rather uneasy, but soon lay down. The respiration was panting, but there was no loss of consciousness or sensation. On the jar being removed,

ether are of so fatal a character, that under no circumstances could it be employed in practice. The rarity of some of these substances, and the difficulty of completely purifying some of the agents whose effects are mentioned in this Essay, may be pleaded in mitigation; but I cannot regard them as entirely excusing professed chemists in supplying an impure article to any party who applies to them to be furnished with such. Experiments may be carefully made, and truthfully reported, and yet be erroneous, if the article used be impure. I do not profess to be an operative chemist, versed in the production of all the combinations modern science has called into existence, but this is no excuse for those whose occupation it is to be so.

at twenty minutes, she immediately jumped off the table, but fell in doing so. For three minutes she walked about unsteadily, then sat for twenty minutes perfectly still, with good, free respiration. On being then noticed, she was pleased, and soon became troublesome from seeking this. When put away for the night, she appeared quite well.

No. 362.—A five-weeks'-old rabbit was placed in a five-hundred-cubic-inch jar, with ten minims of hydriodic ether; temperature, 60°. It was kept in for twenty-five minutes; during the last ten it had lain upon the side, with laborious respiration, some little convulsion, and a constant, apparently spasmodic, rotatory motion of the lower jaw. It continued perfectly conscious and sensitive. On being taken out, its breathing immediately improved, and in six minutes it was scampering about the room, as though it ailed nothing. The next morning it was found dead, cold, and rigid.

Post-mortem examination twenty-four hours after experiment.—Chest: lungs crimson in colour, and full of blood, but not consolidated; no effusion within the bronchial tubes. Heart: both the auricles excessively distended; also the right ventricle, but not to the same extent; the left ventricle was contracted and empty; venæ cavæ quite full; blood all coagulated and black in the heart and large vessels, but in the brain and smaller vessels red. Vessels of the brain and its membranes congested. Stomach, intestines, and bladder full. No trace of iodine in urine. There was unequal contraction of the two irides, and central opacity of both lenses. Whether this existed during life I am not aware.

No. 363.—The same large cat as in experiment No. 361, having been during the day restless, but not appearing ill, was placed in the same jar, (temperature, 60°,) with thirty minims of hydriodic ether. She appeared distressed and uneasy, but did not make any attempt to escape, gradually becoming quiet and sleepy; but it was not until eighteen minutes that she was perfectly insensible. She continued motionless until twenty-five minutes, when she was removed; the ether was not quite exhausted. She was without reflex action, the respiration became more and more feeble, she was otherwise without motion. At twenty minutes after removal, I thought she was about to die, when the nose

being struck, she moved the head, and presently got up and walked away. She improved in every respect; and when left, after one hour and a half, for the night, was much better. The next morning she was found cold and rigid.

Post-mortem examination twelve hours after the experiment.—Muscles natural in colour and rigid. Head: no congestion of any of the vessels; no effusion; there was a distinct smell of the ether, on the brain being sliced. Chest: lungs, emphysematous in parts, of a nutmeg colour, with large patches of a dark slate colour, filled with serum; the trachea contained matter from the stomach; pulmonary vessels all full. Heart: left ventricle contracted and empty; the auricle and both right cavities filled with blood; the venæ cavæ quite filled; the aorta empty; the blood of a dark brick-red colour, of the consistence of treacle; alike on both sides of the heart. Abdominal viscera all congested and loaded with fat; the stomach filled with food. No effusion in any of the cavities; nor was the smell of the ether perceived elsewhere than in the brain.

OBSERVATIONS UPON THE EFFECTS OF THE SUBSTANCES INDIVIDUALLY.

Chloroform.—Not only have I placed chloroform first in the list of agents whose effects are related, but also a greater number of experiments have been made with it than with most of the other substances. Inasmuch as it is that body which is now used almost exclusively in practice, it has attached to it more interest and importance than many of the others. It is, of all the anæsthetics which I am acquainted, (with one exception,) one of the most, if not the most, agreeable, and at the same time it is possessed of very considerable power. It is for the most part pretty constant in its action; but I am also bound to add, it is one of those which require more care in its administration than most of the others, and I would venture to say much more care than has always in practice been exhibited. It is true that many fatal cases in which it has been given are known, but, I am firmly convinced, there are many more fatal cases which have not been reported. Even in those cases which have come to

light, all sorts of explanations, and attempts to explain away the true cause of death, have often been attempted, rather than admit the fact of the person having been killed by the chloroform. This is, perhaps, scarcely to be wondered at; the admission of the fact would be almost like acknowledging being accessory to the death of the patient, which most men naturally shrink from. A careful examination, however, of the preceding experiments cannot, I think, but convince any impartial person that, in reality, death in these cases was caused by the chloroform; either from some abnormal condition or peculiar idiosyncrasy, by which the person was rendered unusually susceptible to its influence; or, as I believe, far more frequently from a want of that experience and care in its administration, which the exhibitor should have possessed and attended to. When I see statements by medical men that they have "boldly administered" chloroform in quantities of from six drachms to an ounce and a-half at a time without any ill effects, I cannot but congratulate both the patient and the doctor that the rashness in employing such quantities has been equalled by the carelessness in administering it, so that by far the greater portion of the fluid has been wasted by escaping into the air of the room, rather than passed into the lungs of the inhaler, and thus the carelessness of the administrator has, contrary to what generally occurs, and which he would do well not to risk again, been the means of escaping from the effects of his rashness.

Two very important practical points, in reference to the administration of chloroform, appear to be proved by these experiments.

1st. That the effects produced upon similar animals by like quantities of chloroform, all circumstances, so far as can be ascertained, being precisely similar, are not identical, the effects being far more considerable in one than another: even upon the same animal the effects are far more decided at one time than they are at another. This, a comparison of experiments 1, 7, 9, 10, 11 and 16, with experiments 5, 6, 12 and 15, will demonstrate; and, especially so far as the different effects upon the same animal are concerned is shewn, most unequivocally in experiments 11 and 12, and in 16 and 17.

2nd. That the intensity of effect appears much rather to depend

upon the quantity of chloroform inhaled in a given time,—the concentration of the vapour, than upon the absolute quantity inspired. Thus a small quantity suddenly and quickly inhaled for a short space of time will produce, not only more rapid and decided effects, but also far more dangerous, than a far larger quantity will do, if taken in more slowly, and consequently in a less concentrated form. Many of the experiments show that when the creature inspired fully and deeply, and the temperature was high, so as to ensure a speedy conversion of the chloroform into vapour, that anæsthesia was not only quickly produced, but was also most decided; also that the effect was more prolonged if the animal recovered, and in many cases terminated in death, as see experiments 2, 3, 4, 5, 6, and 8; compare No. 11 with 12, especially the effect of such a small quantity upon the dog No. 283; also with the cats, experiments 13, 14, and 15. In the first the vapour was not concentrated, but the inhalation was more prolonged; in Nos. 14 and 15 the vapour was more concentrated, but the inhalation not so prolonged; in No. 13 recovery soon occurred; in Nos. 14 and 15 death was occasioned. The same fact is illustrated with the three carp, Nos. 25 and 26, and with other creatures.

Alcohol and Spirits of Wine.—At first my experiments were made with spirits of wine, 64 over proof, or containing about 90 per cent. of pure alcohol; I subsequently procured alcohol as nearly as possible pure, the specific gravity of absolutely pure alcohol being at 60°, 0.796, while that which I used was 0.797, so that for all practical purposes it may be considered pure. Now, although it differs from ether only in containing the elements of an atom of water, being considered by chemists a hydrate of the oxide of ethyle, and agrees with this fluid in many of its chemical and physical properties, yet it differs materially in its physiological. It has no pretension to rank as an anæsthetic. When taken by inhalation its vapour produces very little effect, while the fluid itself, put into the stomach, produces considerable, being the reverse of the action of true anæsthetics; as, for instance, chloroform and the chloride of olefiant gas, which within the stomach produce less effect than even spirits of wine, but by inhalation, infinitely more.

Sulphuric Ether.—If ether be not so powerful in its effects as chloroform, it is certainly not so dangerous in its application; a larger quantity is required to produce a like condition of insensibility, and more time is occupied; the system is not so speedily brought under its influence. In the commencement of the inhalation it is necessary to be very careful not to allow the air to contain too large a proportion of the vapour, otherwise so much irritation of the glottis and bronchial membrane is occasioned, and the respiratory muscles so violently excited to action, that the continuation of the inhalation must be, at least temporally, suspended, sometimes even permanently. Another circumstance is, that before the animal is fully brought under its influence, there is some excitement, which, at times, is very considerable; so much so as to render a patient wholly unmanageable, the only method of calming him being to place the system more fully, and as rapidly as may be, under the influence of the ether; when, however, this is accomplished, if not carried too far, so much depression is not produced as by chloroform, and I think the condition of insensibility may be longer continued without danger when ether is used than when chloroform is. The action of the heart is not rendered so excessively feeble and rapid, and disappears sooner than after chloroform.

To counterbalance this, feverishness, heat, and pain in the head, are more apt to follow. While the action of ether upon the system is, I believe, of essentially the same nature as chloroform, it, in the first instance, is certainly more of an excitant than chloroform, and, as stated, if not used in very large and unnecessary quantities, or very long continued, it does not occasion such depression of the system; hence, in cases where there is reason to suspect any peculiar susceptibility to the action of the depressing influence of anæsthetics,—such as disease of the heart, of an asthenic character, or considerable constitutional debility,—if it be determined to use one of these agents, ether should, I think, be selected in preference to chloroform. So also when the operation itself is likely to produce a considerable shock and depression of the system, or where it is likely to be very long and tedious, then it may fairly be well considered whether ether may not be the safer of the two agents. On the other hand, when the patient is plethoric, or very excitable, or in whom there is a tendency to

fever,—where there is any affection of the head, whether of the brain or its membranes, or predisposition to congestion,—any sthenic disorder of the heart, or disease of any kind in the lungs; if it be, notwithstanding these contra indications, from any other consideration determined to use any anæsthetic agent,—then ether is not the one to be selected on account of its stimulating property.

Spirit of Nitric Ether and Nitric Ether.—Previous to trying the effect of nitric ether itself, it appeared well to ascertain if the spirit of nitric ether, which appears to be an indefinite, or rather undefined, compound of hyponitrous or nitric ether, alcohol, and water, in proportions not ascertained, possessed any anæsthetic property. The two experiments, Nos. 57 and 58, were such in their results as to show that it cannot, in any moderate quantity, or when inhaled for a moderate period, be considered as possessing much, if any, of this property.

Nitric, nitrous, or hyponitrous ether, is a fragrant and by no means disagreeable substance, when first inhaled. If the vapour be not diluted, it produces some degree of irritation and distress; but this soon disappears, when the inhalation is continued without any objection or indication of distress or dislike. It certainly possesses considerable anæsthetic powers, which, however, are not equal to those of chloroform, or even sulphuric ether, and the anæsthesia is more evanescent in its character. A state of total insensibility may be easily induced, and maintained for some time with safety; but the prolonged inhalation of it, even when the vapour is not concentrated, is dangerous, and may be fatal to life, as in experiment 276. In addition to the objection founded on the evanescence of the anæsthesia produced by nitric ether, there is another which, in practice, would be found of a formidable, if not insuperable, nature,—namely, the instable character of this ether. It very soon, especially when any air is in contact with it, undergoes decomposition; it becomes quite acid and more irritating, nitric oxide gas being given off, alcohol, nitrous, and acetic acids remaining. It therefore is not likely to be of much practical utility as an anæsthetic.

Acetic Ether.—Acetic ether possesses a warm, aromatic, agreeable odour. When the vapour is diluted, it is pleasant to

inhale; but when concentrated, it produces at first considerable irritation, as shown by the flow of saliva and tears, and the violent attempts to escape from its influence. This, however, subsides, and the respiration becomes more free. When given as a fluid internally, it produces great distress. I put not more than ten minims upon my tongue; instantly it appeared to penetrate into the substance of it, and I was seized with great distress and a sense of suffocation, as though the respiratory muscles would cease to act, arising, I think, from the vapour in the mouth and pharynx. I am certain none was swallowed, but the stomach immediately became distended, and a very large quantity of flatus was eructated. After walking about for two minutes, a slight perspiration broke out, and the eructation subsided, but there continued a sense of dryness and constriction about the fauces: the pulse was languid, and there was a feeling of weakness, which passed off after a few more minutes; the head was not in the least affected. Though acetic ether certainly possesses considerable power as an anæsthetic, (see experiments 68 and 69,) and is far more stable in its character than nitric, it is not likely to be used in practice, as it is inferior to several other substances.

Chloric Ether, Chloroform, and Spirit of Wine, Mixed.—From the resemblance, in many of its qualities, of chloric ether to chloroform, I thought possibly it might possess the good properties of this without its depressing effects; and if so, that it would prove an useful agent. The effect of the experiments, Nos. 79 to 85, will show that, to a great extent, this idea is not ill-founded. Chloric ether produces less irritation than the other ethers; indeed, there are none of those violent attempts to escape as with nitric and acetic, or even sulphuric. It is very pleasant to the smell and taste, and is freely respired. In none of the animals were any convulsions produced, nor any unpleasant effect, while the degree of insensibility was sufficient for any purpose. This, so long as the vapour was inhaled, continued, but afterwards speedily passed off. It has for some time been used internally as a valuable medicine, and did we not possess so safe, and, at the same time, so powerful an anæsthetic as we do in the chloride of olefiant gas, would, I consider, be well worth a fair trial in practice; even as it is, were neither it nor chloroform at hand,

I should not for a moment hesitate in using chloric ether instead. The experiment upon the cat, No. 85, will show how large a quantity of the ether, and how much time was required, in order to destroy the creature; and the post-mortem appearances will show the condition induced in the various important organs. Experiment, No. 84, was instituted for the purpose of ascertaining if a mixture of chloroform and spirit of wine would produce the same effect as chloric ether; the results shows, that though chemically chloric ether may be regarded as a mixture of the two bodies, yet that the relation which they bear to each other in chloric ether is not the same as when they are mechanically mixed, and that the effects are not so satisfactory.

Hydrochloric Ether.—Hydrochloric ether, or the chloride of ethyle, is a pleasant ether of a very feeble odour, and is soon converted into vapour. Its power as an anæsthetic is very low. It is more volatile than most of the ethers, but is far less aromatic and pungent; as in odour so in effect, it more resembles alcohol than any other ether.

Hydriodic Ether.—The iodide of ethyle is a colourless, ethereal fluid, of a strong disagreeable odour, of the same character, but not so intense as the bisulphuret of carbon: it also calls to mind phosphorus, especially after a short exposure to the air. In taste, it is not so pungent as many of the ethers, but strongly phosphorus-like. It does not excite much irritation when inhaled, though it appears to be disagreeable. The experiments show that whatever anæsthetic property it might possess, (and this is not insignificant,) it never could be employed in practice, as its action is so very deleterious. Out of the four animals experimented upon, the three which were rendered insensible all died, and the fourth had not sufficient of the vapour to render it in the least insensible, and yet for two or three days it was doubtful whether it would recover. The poisonous property, the smell, taste, and strongly luminous character, made me conjecture that it was not a pure article which I used; I therefore wrote to state this to Messrs. Gale, Baker and Co., of London, who sent it. They assured me it was made by a "first-rate chemical house," and was perfectly pure; but as I still suspected it, I requested the name of

the makers, which I give, Messrs. Heathfield and Burgess, Finsbury, London. Like the bromide of olefiant gas, its immediate effects are not so dangerous as the consequences of inhalation in a few hours are; even where sufficient to produce insensibility has not been used, and the animal to all appearances has been perfectly well, death will supervene. As this does not arise from irritation or inflammation of any organ, nor from paralysis of any part, it may probably arise from the blood being poisoned. In one instance, the odour of the ether was distinctly perceptible in the brain, twelve hours after the inhalation had taken place.*

Hydrobromic Ether.—The bromide of ethyle is a pleasant, rather fragrant ether, not of very penetratiug smell, is sweetish to the taste, at first rather insipid than not, but afterwards it is more pungent. It possesses very considerable anæsthetic power. Its inhalation does not produce irritation, and does not appear to be unpleasant. When not used in large quantities, the animals soon recovered from a condition of complete insensibility, without any disagreeable symptom; and when given, as in No. 98, in a full dose, the creature sank down, without moving a muscle, merely from its weight, into a state of the most profound anæsthesia, within one minute after being put into the jar. The fact of respiration continuing at all during fourteen minutes in such a condition, shows that this fluid is more manageable than some others.

Dutch Liquid—Chloride of Olefiant Gas.—This is not only an aromatic and very pleasant ethereal fluid, but a most valuable one; indeed, I believe one of the most valuable anæsthetics yet tried. In general properties it much resembles chloroform; but in composition it differs materially from it, in containing a much less proportion of chlorine and more hydrogen, as compared with carbon, in an atom; and its boiling point is very different, as a reference to the heads of the respective experiments will show.

A comparison of the experiments with chloroform and with the chloride of olefiant gas will show, that in no one respect is the former fluid superior to the latter. The animals were rendered perfectly anæsthetic in quite as short a time, showed no uneasiness

* See also the four experiments made with perfectly pure hydriodic ether, obtained from Mr. Bullock, page 315.

while passing into this condition, remained perfectly still while in it, and on recovering were altogether free from any unpleasant symptoms. The condition of anæsthesia may be rendered as profound as possible, and quite as prolonged as can ever be requisite in any operation; and, so far as I can judge, there is not so much weakness and depression induced as by chloroform; indeed, I think it probable that animals rendered so utterly senseless by chloroform as Nos. 102 and 104 were, would not have recovered. While the large quantity required in No. 108 to destroy the cat, when I wished to kill it, shows, that if as small a quantity of it as of chloroform will induce an anæsthetic state, a much larger quantity is required to destroy life, and, consequently, that the chloride of olefiant gas is by so much the safer of the two fluids.

The seven cases mentioned, in which it was given to patients during operations with perfect success, are sufficient to show its safety; but I have since given it, in several other serious and important operations, to two women in labour, and several times it has been inhaled for experiment, so that no doubt can remain as to its value. When I used it, I was not at all aware it had previously been tried; but both Drs. Simpson and Snow had tried it, and were led to consider it a dangerous preparation which could not be used. This error, I believe, arose from their using an impure preparation; one which possibly contained free chlorine, which would account for the irritation induced, and must always be avoided with the utmost care; a point, however, upon which there can be no great difficulty, as I have used chloride of olefiant gas perfectly pure, prepared by three different chemists.

Bromide of Olefiant Gas.—Having ascertained that the chloride of olefiant gas acts so pleasantly as an anæsthetic, I was desirous to ascertain if the analogous compounds of iodine and bromine possessed similar properties. The iodide being a chrystalline substance, (corresponding with iodiform,) is not adapted for the purpose; I therefore only obtained the bromide.

It is, of all the substances I have tried, one of the most agreeable and pungent; its odour strongly resembles that of the flower of the heliotrope. In taste it is one of the sweetest bodies I know, more so than sugar; for if the tongue be touched with

it, and sugar be afterwards put into the mouth, the sweetness of the bromide can be perceived above that of the sugar. It does not produce any irritation of the tongue. The specific gravity of the fluid is considerable, and the density of the vapour is great. It is a fluid of a very pale straw colour. It is inhaled without irritation or any repugnance. Though it produced insensibility, before the animals were reduced to that state, the respiration was most laborious; and though all appearance of distress speedily disappeared on the animals being released, in a few hours afterwards they all died. In this respect it differs from other substances, immediately after the experiments the animals appearing well, and soon after dying, effects which would more justify the opinion of the blood being poisoned by it than (perhaps, excepting hydriodic ether,) with most of the other substances tried. With them, if the immediate effects pass away, the animal may be considered safe; not so with this, as the experiments will show.

Oleum Æthereum.—When I first tried this substance, which was amongst those first used, I thought I had discovered an agent likely to be very useful, as it appeared to possess more power than any of the ethers, and yet to be safe. It happened that the experiments first made were those in which the greatest insensibility was induced, hence (as other experiments did not confirm the first,) the number made, in order to ascertain the true value. More extended observations have shown that it possesses but doubtful, if any superiority over sulphuric ether; indeed, it is not improbable that it owes its property to the ether which it contains. This appears to be in uncertain proportions, and the effects are not uniform. In some animals the insensibility was profound, as in No. 118, while in others it was very little. Out of three instances where I administered this fluid to patients, in one, considerable excitement was produced, and the man could not be prevailed upon to continue the inhalation, not from any dislike to it, or from any other unpleasant effect, but merely from his excited, half-unconscious, self-willed condition; in the other two persons, very little effect was produced. It is pleasant and very aromatic, this probably arises from some volatile oil combined with it. This aromatic property led me to the supposition that it might produce less depression than chloroform. The less specific gravity of these

three specimens which I used than that stated in the Pharmacopœia and by chemists, as well as the less anæsthetic effects produced by the latter of the specimens which I obtained, shows it to be a compound of very uncertain proportions, and therefore not to be depended upon, even were its powers greater than they are.

Heavy Oil of Wine.—Although this substance is closely allied to the ether group, from the decomposition of which it is formed, and it is a rich hydrocarbon, as an anæsthetic it is of no value, probably, for two reasons. First, its combination with an acid; and, second, from its not being very volatile. It is true that in *Turner's Chemistry* it is described as being without action on dry vegetable colours, and as a colourless fluid, in neither of which particulars did the specimen I tried agree. That which Mr. Morson prepared for me possessed a very acrid, irritating character. The explanation of this discrepancy I have already stated. It may be said, the quantity I tried was not sufficient to produce a decided effect. This may be true; but had a larger quantity been used, the irritation would have been too great to have been borne. If, therefore, its volatility were sufficiently great to give it rank as an anæsthetic, its unstable and uncertain composition, and irritating quality, at least when so changed, would prevent its useful employment.

Aldehyde.—According to modern chemists, aldehyde is the analogue of alcohol, being the hydrate of the oxide of acetyle, as alcohol is the hydrate of the oxide of ethyle. It unquestionably possesses considerable anæsthetic powers, but it is not likely to be employed in practice. Its vapour is of a singularly irritating and suffocating character, producing, even when inhaled for only a short time and in a diluted condition, very unpleasant sensations; and evidently, when inhaled in a more concentrated form, as shown by the violence of animals in attempting to escape from it, a most distressing effect.

When used in comparatively small quantities it occasions great distress, without loss of sensation or consciousness, and when used in sufficient quantity (though the quantity required is not very large) to induce unconsciousness and insensibility, it is dangerous,

death being likely to supervene, as in No. 144, though possibly the pregnant condition of this animal might conduce to this effect, but which is not very evident.

It is a very curious circumstance, when so much irritation is produced by the inhalation of aldehyde, and also of several of the other fluids, to observe how very quickly this subsides, without any ill effect; and that when the animal has died while breathing them, on an examination the bronchial membrane is usually found uncongested, rather pale than not, and without any increased secretion.

The facts of the continued pulsation of the fœtal umbilical arteries after the maternal heart and circulation had entirely ceased, and the body of each fœtus had ceased to move, though the uterine fibres and maternal intestinal muscles continued to contract, are physiological facts worth bearing in mind.

Mixed Substances.—As no particular advantage appeared to result from the combination of substances, whose effects are related under this head and amongst other experiments, as Nos. 49, 71, 77, 153, 4 and 5, 179 to 184, 214, and others, it will be unnecessary to detain ourselves with any observations upon them.

Iodoform.—Iodoform is a substance but very little known to the profession. It is thus described in the eighth edition of *Turner's Chemistry*, page, 1,010:—"It crystallizes in pale yellow, shining scales, having a slight, but disagreeable, odour, resembling that of saffron, and adhering strongly to the hands or to substances brought in contact with it. It is insoluble in water, very soluble in alcohol, ether, and pyroxylic spirit. It sublimes at 212°, and at 248° it is decomposed, yielding iodine, carbon, and hydriodic acid."

As its constitution is exactly analogous with chloroform, the three atoms of chlorine being replaced by three atoms of iodine, I thought it worth trying, and accordingly requested Mr. Morson to prepare me some, which he was good enough to do. The general appearances of it correspond pretty nearly with the description in Turner, except that the scales have only a faint yellowish tinge, perhaps from its purity; they have a soft pearly, somewhat glistening, appearance; the odour is most peculiar, very penetrating, and extremely permanent, far more than that of most

substances. From its penetrating odour I at first used it with great caution; this, however, was needless, as it appeared to produce hardly any effect, whether by inhalation or by the mouth; indeed, when placed upon my own tongue, very little sensation was produced: this I attribute to its insolubility and unvapourizability. It will remain exposed to the air for days, without any apparent change, and may likewise be exposed to a temperature of 150° for a considerable period without any effect being produced, except it becoming of rather a deeper yellow; yet it cannot be absolutely fixed, inasmuch as its vapour is very perceptible, and adheres to everything. In Turner it is stated to be very soluble in alcohol, ether, and pyroxylic spirit. I thought to procure its effect by giving it dissolved in one or other of these fluids, and thus get it vapourized, but on trial, I found it to be nearly insoluble in these. Of this I informed Mr. Morson, whose statement agrees with that in Turner; but still, in my hands, the fact is as stated, though Mr. Morson assures me the specimen is pure, and was precipitated from alcohol. Possibly it may be formed by the mixing of two substances dissolved in this fluid, and yet, when formed, not itself be very soluble.

Either, then, iodoform does not support the idea which I have before thrown out respecting the doctrine of substitutions, or the chrystalline and fixed character of the substance, differing so widely as it does from its analogue in composition, chloroform, shows that with substitution of elements we must also have, as indeed would be expected, isomorphism, otherwise the analogy in action upon animal bodies will not be preserved any more than analogy in physical and chemical characters.

Olefiant Gas.—Heavy inflammable air, bicarburet of hydrogen, or olefiant gas, by one or other of which names it for long has been known, is a pure hydrocarbon, containing the two substances in equal ratio, and is therefore, from its gaseous form, as well as its composition, a very favourable substance for determining if these two substances, in combination alone, are capable of producing anæsthesia. The result of the experiments is in the affirmative; that they are capable of inducing this state. The post-mortem appearances also confirm the similarity in action. There is one point connected with these appearances which is

very curious, and which may also be observed with some of the other hydrocarbons, viz: that when the colour of the blood is found to be altered, the effect is seen not to be in rendering the blood darker, but more florid. To this we shall again allude; but when the *rationale* of respiration is taken into consideration, it is an effect which few would, *a priori*, be prepared to find.

Though olefiant gas is an anæsthetic, and consequently is of considerable importance in elucidating the action of these agents, it is not one of those which are likely to be used in practice. Not only would there be the difficulty and trouble in preparing and preserving it, but it is not a safe and manageable agent; since, when employed in innocuous doses, the anæsthesia is not complete: when used in larger, death may not improbably be caused. 10 per cent. of the gas does not appear to produce such a degree of insensibility of any permanence as could be depended upon in a painful operation of even a moderate length; 15 per cent., though causing total insensibility, also induces a dangerous condition, while life is speedily destroyed by from 20 to 25 per cent.

Common Coal Gas.—Common coal gas, when prepared with tolerable carefulness, consists principally of the light and heavy carburetted hydrogen gases; "but, besides these ingredients, an inflammable vapour, free hydrogen, carbonic acid, carbonic oxide, and nitrogen gas. The discoveries of Mr. Faraday have elucidated the subject still further, by proving that there exists in oil gas, and by inference in coal gas also, the vapour of several definite compounds of carbon and hydrogen, the presence of which, for the purpose of illumination, is exceedingly important."

Coal gas is not only a powerful anæsthetic, but, so far as my experiments go, it is also a very safe and manageable one. The animal is quickly brought into a state of unconsciousness and insensibility, and that without the least appearance of suffering. It does not act as an irritant, it does not excite a cough, there is no repugnance to the inhalation of it, and the condition of anæsthesia may be safely maintained for a period sufficiently long to allow the performance of most operations.

It appears to deserve a full and fair trial, and if in practice it should be found, as I believe it will, to be successful, the

cheapness of it would be a recommendation not unworthy of attention, should its gaseous form not prove too inconvenient. It affords another instance of a hydrocarbon producing an unnaturally bright condition of the blood.

Benzole.—Benzole is not nearly so pleasant in smell or taste as chloroform or Dutch liquid, the general appearance of which it resembles. It has a strong smell of coal naphtha, or common coal gas. It is a powerful anæsthetic, and though during its inhalation the animal appears much distressed, it is one of the safest. I have seen animals recover from apparent death after its use, when I had not the least expectation of their so doing. The anæsthesia produced by its inhalation is profound, but before becoming insensible, there generally are the most remarkable muscular twitchings over the whole body. At first these merely amount to trembling, though they sometimes resemble an attack of ague; but as the unconsciousness increases, these movements assume more the appearance of convulsions. In experiment 323, where the frog and newt were exposed to the vapour of benzole, they appeared dead, but subsequently became quite well. Here the first indication of life, especially in the frog, was a sudden start of the limbs, occasioned by taking hold of one leg. I should not have known the movements from those excited in a dead animal by galvanism.

Though a powerful and safe agent, this distress, and the oppression in breathing occasioned by benzole, will prevent its employment in practice. It affords an illustration of the action of an agent, where carbon is in the proportion of two atoms to one of hydrogen.

Camphor.—Camphor is one of the numerous forms to which the combinations of carbon and hydrogen give rise, as stated in the experiments, according to its ultimate analysis, its composition, so far as proportion of elements is concerned, does not differ very materially from that of sulphuric ether, a more essential difference being apparently in the mode in which the atoms are united to constitute these respective bodies. In ether, 5 of hydrogen, 4 of carbon, and 1 of oxygen are united to form one atom of ether, whereas it is supposed 10 atoms of carbon, 8 of

hydrogen, and 1 of oxygen are united to constitute 1 of camphor; hence they are not strictly isomeric; nor do they produce the same effect upon animals. It is one of those substances which appears to have greater effect, when taken into the alimentary canal, than when inhaled. Its solid form, perhaps, conduces to this. It is difficult, without employing more heat than could be borne, even when the camphor is dissolved, to get a sufficiently concentrated vapour, in a pure form, to try its effects fairly, and consequently we rather get its stimulant property; which appears to be the primary action of nearly all of these triple compounds, as shown, both when the dose is not sufficiently strong to cause complete anæsthesia, or before this state supervenes when the dose is larger. The symptoms caused by a poisonous dose of camphor, taken into the stomach, would confirm this view.

Naphtha.—Naphtha is stated to be a pure hydrocarbon; indeed, that which is called potassium naphtha must be so, since it is used for the preservation of this metal. The effects of three kinds were tried, wood or pyroxylic spirit, potassium or mineral, and coal naphtha. Of the three, the latter is the only one which possesses much anæsthetic power; and this not to such a degree as to be practically useful. Though it will induce loss of consciousness and sensation, it also produces so much distress, convulsion, and weakness, as to make its employment painful. Upon fish its effect is very similar to that of hydrocyanic acid. Though the specimen I tried was rectified, and stated to be perfectly pure, its odour strongly resembled that of coal gas. Possibly its more powerful action, than the other varieties, depends upon some substance which it still retains in solution. Potassium naphtha is rather more powerful than wood, but both produce, especially potassium, great distress, difficulty of breathing, and weakness, but have very little anæsthetic power—too little to be of any use.

Oil of Turpentine.—Oil of turpentine is another of the pure hydrocarbons, and appears to be composed of the same number of atoms of hydrogen and carbon as camphor, being minus the one atom of oxygen. The experiments show it to be a decided anæsthetic, but one which is by no means likely

to be used. It occasions very great distress; the convulsions are excessive, and it apparently affects the brain in a great degree, producing, so far as can be judged of, excessive giddiness; indeed, this effect is perceptible to most persons in inhaling it, even in a very dilute form; nor can unconsciousness be produced without danger to life, as No. 198 shows. How far the convulsions may be dependent upon the cause before alluded to under the head "camphor," of want of sufficient concentration in the vapour, the boiling point of turpentine being as high as 312°, is doubtful.

Many of the essential oils are stated to be identical in composition with the oil of turpentine, but it does not appear necessary to try their effects.

Creosote.—Creosote is another of those substances which, taken into the stomach, act very energetically; when inhaled it produces, comparatively, little effect, probably on account of its fixed character. It cannot be regarded as an anæsthetic; even were it so its effect upon the lungs, in occasioning pulmonary apoplexy, would prevent its employment. It is curious that so little congestion of the bronchial membrane should result, even from its lengthened inhalation, while such great irritation is produced by the application of the liquid to any part.

Protoxide of Nitrogen.—Knowing the effects of the protoxide of nitrogen when breathed for a short time by man, and the statements in physiological and chemical works as to its effects when inhaled, ever since Sir H. Davy's celebrated experiments upon it, it appeared to well deserve a trial. Indeed, we might go farther, and refer to the account Priestly gives in his history of the discovery of dephlogisticated air, of putting two mice into it, and also of breathing it himself.* With its effects I confess myself disappointed.

Had not the experiments been conducted with great care, and the gas made with every attention to its purity, I should have suspected some error; but this I do not believe did occur, (the gas was made by Mr. Staniland, who, I may mention, kindly

* *Experiments and Observations on different kinds of Air*, vol. ii., pp. 44 and 100.

made this gas, the oxygen, and carbonic oxide, for me, and assisted in the experiments with them; while, for the making of the olefiant gas, hydrogen, oxygen, sulphuretted hydrogen, and carbonic acid gas, and assisting at the experiments with them, I am indebted to the kindness of Mr. Morley, both gentlemen being among my colleagues at the Leeds School of Medicine.) The gas was pure and well washed, and the experiments were conducted with every care, yet the effects of No. 206 and No. 207 contrast very strongly with those of No. 209 and No. 210, especially with No. 208, wherein death ensued in less than five minutes. They are quite sufficient to show that nitrous oxide never could be employed as an anæsthetic, and that the inhalation of it is not altogether so harmless as is generally stated. Probably, when inhaling it in the ordinary way as a laughing gas, almost as soon as it begins to produce its effect, very little more is taken into the lungs, and insensibility is not very frequently occasioned, but only its first effect, the drunkenness and excitement, though even a very small quantity will quickly stupify some persons; these experiments, however, clearly prove that with animals the state of insensibility, when safe, passes off so quickly as to be practically useless, while if it be rendered more profound or more prolonged, it is highly dangerous. Moreover they indicate its action to be very uncertain, that of three animals, of the same species, and similar as to age, size, and sex, with the same quantity of gas, one was killed in five minutes, while the others, after being exposed to the gas for nearly three times as long, showed hardly any symptom of being affected by it. The post-mortem appearances in the cat destroyed by the protoxide of nitrogen may also be referred to, as showing that the action of it differs from that of the hydrocarbons and their compounds, the condition of the heart and lungs being very different. In animals destroyed by them, the lungs are generally much collapsed, showing, I believe, but little action upon their structure. The less the lungs depart from a natural condition, the more they will, in my opinion, be shrunken on the thoracic parietes being opened, the pressure of the air being then equalized: if there be no unnatural deposit or effusion, or the cells be not emphysematous, then the natural resilience of the lungs comes into play; whereas, when from any cause the structure is altered, this cannot take effect, and consequently the lungs are more bulky; but they do

not present this appearance after death from nitrous oxide. The condition of the heart, also, especially of the left ventricle, materially differs. It is curious to remark, that with a gas so rich in oxygen the blood should be dark, while with some of the pure hydrocarbons, where there is no oxygen, it is perfectly florid, a fact which it is very difficult to account for in accordance with the received notions of physiology.

Hydrocyanic Acid.—Very shortly after the introduction of chloroform, in giving it by inhalation to an infant, who was suffering most dreadfully from long continued convulsions, which had resisted every means I had tried, I was so struck with the resemblance in the symptoms it produced in the child, and the appearance of the animals to whom I had administered hydrocyanic acid, when pursuing the inquiry into the effects of this acid upon animals, that I determined to ascertain, as far as practicable, if the idea then formed was correct. Further inquiry has satisfied me that it is so; and I have no doubt, from the symptoms during life, and the appearances after death, that the *modus operandi* of these two substances is essentially the same.

Hydrocyanic acid affords a good instance of a hydro-acid, in which the hydrogen is united with a radical base composed of carbon and nitrogen. It is a most powerful anæsthetic, indeed, the most powerful with which I am acquainted, its power being so great as to constitute the objection to it, and to render it so unmanageable as, probably, to prevent it being useful in practice. This energy, I suspect, arises from the nitrogen it contains. It would appear that those compounds into which nitrogen enters, (as the vegetable alkaloids,) exert a more energetic action upon the animal economy than any other substances; and further, that this action appears to be more specifically upon the nervous matter. Whether this arises from any analogy in composition, or from more readily entering into composition with its substance, or from being endowed, so to speak, with some allied power, force, or energy, by which it is capable of exciting more readily corresponding or opposing phenomena, (whether vibrations, undulations, or whatever other change it may be,) as nervous matter itself, would, in the present state of our knowledge of these subjects, be idle to speculate upon; and, perhaps, the bare mention of an idea which it is difficult

to find language exactly to convey the meaning of, may be thought to be merely idle dreaming and nonsense.

Hydrocyanic acid acts with nearly equal force and rapidity, however given, whether by inhalation, applied to any portion of the alimentary or genito-urinary mucous membrane, or by injection into the veins, also with great power in contact with the cellular membrane, hence I conclude, (considering its composition as well,) that it possesses more affinity for, and control over, animal tissues, or some parts of them, than many other substances.

Conia.—Some time back, when wishful to try the effect of a pure hydrocarbon with elements in equal ratio, I asked Mr. Morson if he could name one; he said not, but suggested conia, as being a volatile alkali. In the last edition of *Turner's Chemistry,* the composition of conia is given as consisting of equal proportions of carbon and hydrogen, it being doubtful if nitrogen is present or not. From the effect of it I should not entertain any doubt of the presence of nitrogen. The experiment will show it to be of a very destructive character, being most inimical to animal life; that when inhaled it acts less energetically than when given by the mouth; and that when unconsciousness comes on, death speedily supervenes. Conia appears to produce intense vertigo; indeed, the symptoms during life, and the post-mortem appearances, would all indicate that the brain itself is more primarily and powerfully acted upon by it than by any other of the substances tried. In all the animals destroyed by it, not only were the larger sinuses filled with dark blood, but the vessels of the pia-mater, and of the substance of the cerebrum and cerebellum, were much congested. There was also serous effusion.

Conia can hardly be ranked as an anæsthetic. It is undoubtedly a narcotic, and affords a good illustration of the distinction between anæsthetics and narcotics.

Hydrogen. — Though hydrogen gas has been so frequently experimented upon, that its effects upon animals may be supposed to be pretty generally understood as entirely negative, yet in pursuing this inquiry it appeared to me to be desirable to make a few experiments with it, for a twofold purpose. First, of ascertaining the effect of the mere absence of oxygen; and,

secondly, as we have seen that a pure hydrocarbon possesses an anæsthetic power, to determine, if possible, if this effect is to be attributed to the compound body, neither the hydrogen nor carbon separately possessing the property; or if either of them does possess it, then to which of the two it does belong.

The experiments are perfectly conclusive, in showing that pure hydrogen does not possess any anæsthetic property whatever, and, as is well known, that it is perfectly innocuous to animals; but I think most persons will agree with me in my surprise at the length of time which an active warm-blooded animal is capable of living, not merely in an atmosphere containing a large proportion of hydrogen, as in No. 222 and 223, but in one of pure hydrogen. Certainly the statements of physiologists would not lead to the belief that a dog could remain sensible and uninjured, (giving off a large quantity of vapour,) during the space of an hour in pure hydrogen.

Carbonic Acid.—As it is impossible to give pure carbon by inhalation, there only remains to give it in combination with oxygen, as carbonic acid, or oxide. These gases it also appeared desirable to give on their own account.

Carbonic acid is certainly not to be accounted an anæsthetic. It produces stupor, and when long continued, death; yet this is evidently from a different cause than that induced by a hydrocarbon; with the acid it doubtless results from the blood being poisoned. The action upon the nervous system is secondary; yet even here, life is maintained longer than is generally supposed. It is stated in the best works on physiology, that when one-tenth part of carbonic acid is present, the air will no longer support life. This statement requires some modification; it should be added, permanently. It is doubtless true, that for any lengthened period it could not support life; but in No. 225 we see an animal remaining altogether unaffected for the space of fifteen minutes, in an atmosphere containing, to begin with, one-twelfth part of carbonic acid, and, consequently, considerably more before the close of the experiment. In No. 226, a dog lived without loss of consciousness or sensation for fifteen minutes, in an atmosphere containing one-sixth of carbonic acid; and in No. 227, another dog was kept, during fifteen minutes, in an atmosphere containing

one-third part of carbonic acid, and yet on removal he quickly recovered. Experiment 227 affords a valuable and satisfactory confirmation of the correctness of the opinion commonly entertained, that where a candle will burn, there an animal can breathe; for in that experiment the candle was *instantly* extinguished, while the dog, although immediately affected, recovered after fifteen minutes immersion.

Carbonic Oxide.—Carbonic acid gas, as compared with the oxide, is harmless. This is a violent and speedy poison, even when diluted to such an extent as would render the acid innocuous. The effects of carbonic oxide upon the lungs and the blood are very curious, and may possibly be caused by the oxygen which it contains; but the poisonous effects, when at all concentrated, and its anæsthetic, when sufficiently diluted, must certainly depend upon the carbon; for an animal will live in pure oxygen for some time, and in diluted for any length of time. If carbonic oxide be used in as concentrated a state as 5 per cent., it will produce, in a very short time, dangerous and distressing symptoms. In No. 232, where only $2\frac{1}{2}$ per cent. was employed, before insensibility came on, and as sensibility returned, before the recovery was complete, considerable distress was exhibited. This was, to some extent, also observed in No. 234, where not more than 1 per cent. of the oxide was used before the cat became insensible; but when in this condition it remained for twelve minutes perfectly easy and senseless, and also on recovery did not show any signs of distress.

The manner in which the two very young pups supported for so long a period the inhalation of carbonic oxide, affords a curious contrast to the other animals, and is another illustration of the fact, that the function of respiration in the new-born does not all at once assume that importance in the economy which it afterwards possesses.

Though there is no doubt that when sufficiently diluted carbonic oxide acts as an anæsthetic, it is not likely to be employed for this purpose. I shall again have to refer to this property, but I would here just call attention to the fact, that of all the agents which we have experimented with, which are possessed of any anæsthetic power, carbon enters into the composition of each one, while every other element may in succession be excluded or exchanged, and yet this property continues.

Bisulphuret of Carbon.—The odour of bisulphuret of carbon is most offensive and filthy, being more like a concentration of that arising from putrifying fish and cabbage, than anything else I can compare it to. The taste is very pungent, but not so disagreeable as the smell. When animals are placed in it, they at first appear to dislike it very much, but this seems in a great degree to subside, and there is no difficulty in their inhaling it. A very copious flow of saliva is induced, but not much cough, and there is no indication of the bronchial membrane being irritated. It might be supposed, from its filthy smell, there would be great repugnance and difficulty in its inhalation, but this is not the case. Though it certainly possesses anæsthetic property, it is not likely to be used in practice; for besides its excessive offensiveness, when used in small quantities, its power is not sufficient to induce total insensibility, and when a larger dose is employed, it is apt to occasion violent convulsions or death. It appears to affect consciousness more than sensibility, that may be altogether lost, while this is not destroyed: giddiness and nausea are caused, and vomiting or purging are often occasioned, which appear to show that the brain is more affected by it than by some other agents. It appears to act more powerfully upon amphibia than upon warmer blooded animals. Its stimulant property is shown by the instantaneous effect it produces upon frogs and toads, as well as higher animals, even when they appear, and to ordinary impressions are actually so, wholly insensible, from the action of other anæsthetics. If a drop or two of the bisulphuret of carbon be put in any vessel where animals are lying in an anæsthetic condition, they immediately start up and move as though in pain; and if the dose be not very small, they speedily die. (See No. 318.) So also its local action produces considerable pain, and is followed by considerable inflammation and swelling, as see No. 340.

Chloride of Carbon.—The chloride or protochloride of carbon, in appearance, very strongly resembles chloroform and Dutch liquid, but in smell it is not so pungent or aromatic, and in taste not so sweet; it is, however, remarkable how fluids, having such different compositions as these three have, should have so close a general resemblance in appearance and properties. I am not aware that

any one has tried the effects of chloride of carbon besides myself. Dr. Snow mentions, in his list of substances, the *bichloride* of carbon, but does not relate any experiments with it, though I presume he must have performed some; and, very probably, under the term "bichloride," he may mean this fluid, as the term is not used in either Fownes nor in the eighth edition of Turner; but in the latter the dichloride is spoken of as a chrystalline fibrous substance. It is, therefore, not applicable as an anæsthetic. The chloride is a safe and not unpleasant anæsthetic; in action not dissimilar to chloroform and chloride of olefiant gas, but not, I think, quite so powerful as either of these. The foregoing experiments, however, are, I think, sufficient to justify its trial upon man; and should it be found to answer, it will be valuable, as being the cheapest of all the fluids which have yet been proposed, at least such as are likely to be used.*

Sulphuretted Hydrogen.—As the combination of sulphur with carbon certainly possesses some anæsthetic power, I was induced to try if the union of sulphur with hydrogen had corresponding properties. Though I was prepared to find sulphuretted hydrogen a most potent poison, I must say I was hardly prepared to find its action so intense and instantaneous. It may be that

* As this sheet was passing through the press, and since the preceding one, containing the experiments with the chloride of carbon, was struck off, I have had reason to suspect that the substance I have been supplied with as chloride of carbon, is not exactly what it ought to be, but that it contains hydrogen. I had expected to have received some chloride of carbon through the kindness of Mr. Bullock, (this gentleman anticipating the receipt of some, to be made by a new patent process;) but as after waiting some time it did not arrive, I applied to Messrs. Gale and Co., to either prepare or procure me some, they promptly sent me an article as chloride of carbon, which, as I have remarked above, in general character bore considerable resemblance to chloroform and the chloride of olefiant gas; but, inasmuch as these two fluids, though different in composition, specific gravity, and boiling point, in general characters are not unlike each other,—and as, on consulting the fifth edition of *Turner's Chemistry*, (for in *Fownes' Manual* and the eighth edition of Turner, 1847, very little is said of the character of chloride of carbon,) I found it stated, "This chloride of carbon is a limpid, colourless liquid, very similar in odour and appearance to the oily fluid which chlorine forms with olefiant gas," as well as the respectability of the parties supplying it,—I had no reason to doubt the purity of the substance. I have earnestly sought from the makers to obtain that exact statement of its composition which would be satisfactory, but hitherto without success. This, however, I will do, and propose to fully investigate the properties of all the

phosphuretted and arsenicated hydrogen are more powerful, but of all the substances, the action of which I have seen, I do not know of one to be compared with it. In No. 246, a dog being exposed to an atmosphere containing only 1 part in 200, for the short space of 25 seconds, was irrecoverably destroyed.* It certainly is not an irritant poison, and though it probably acts primarily upon the nerves by destroying their action, it also poisons the blood and changes its properties, perhaps, at once it destroys its vitality. It is curious that water containing this gas in solution may be drank in considerable quantity, yet that so very small a proportion inhaled should act so prejudicially. As sulphuretted hydrogen is one of the gases which is generated by decomposing vegetable and animal matter, emanating from drains and cesspools, &c., may it not, in part at least, account for the depressing action of their exhalations, and the fatal influence of malaria?

Bromoform.—Bromoform, when seen in substance, is a dark-coloured, rather thick-looking fluid, but when seen by transmitted light, it is of a full, rich, dark red-brown colour, a very thin layer, having a deep purple tinge. It drops more freely from the bottle

compounds of chlorine with carbon, whether alone or in combination with hydrogen. The experiments, with the results, shall appear in the *Journal* as soon as practicable. In the mean time I would wish these experiments upon the chloride of carbon not to be regarded as altogether satisfactory and final, lest I should have been deceived in the exact composition of the substance. I should mention that two days ago I gave the fluid sent to me as chloride of carbon to a person under amputation of the leg. The action was pleasant and satisfactory, but a considerable quantity was required, nearly four drachms. It, not improbably, is a combination of chloride of olefiant gas with spirit of wine, and, perhaps, only differs from the fluid sent to me by the same parties as Dutch liquid, in containing less of the chloride, for I am not satisfied that this does not contain some spirit. But, inasmuch as I have made a great number of experiments (and employed it with success during operations) with Dutch liquid, which was prepared by Mr. Morson, and also by Mr. Bullock, I have no doubt as to the general correctness of the statements with regard to its action, for no one would doubt the purity of an article prepared by either of these gentlemen. The combinations of chlorine, carbon, and hydrogen, appear to be exceedingly numerous, and by no means well defined or understood. The exact proportions in which the atoms combine, even with the same process employed, appear, so to speak, to be capricious, or rather to depend upon very slight modifying causes, which as yet are not explained or apparent to the manufacturer himself.

* Thenard states, that 1 part in 1,500 will kill a bird, 1 in 800 a dog, 1 in 250 a horse.

than its appearance could indicate. The smell of it, in mass, is rather agreeable than not, but it is not nearly so penetrating and aromatic as the ethers, chloroform, or Dutch liquid. When a small portion is diffused upon the hands or a cloth, it is identical in character with iodiform, without, however, being quite so powerful or permanent. The taste is very pleasant and sweet, without much pungency. It evaporates slowly. The density of the vapour I believe to be high, but do not know it exactly.* This fluid acts as an agreeable anæsthetic, without producing any irritation whatever, and might probably be successfully employed in practice, were it an article of easy production ; but, inasmuch as it does not possess any striking superiority in any respect over other substances of a far cheaper character, its cost will be an effectual bar to its use. I was, however, wishful to ascertain its effects, as forming a link in my chain of reasoning upon the action of these bodies.†

Injection into the Veins.—Experiments 251 to 256, show the effect of chloroform, sulphuric, and acetic ether, when thrown directly into the veins, and prove most unequivocally, not only the very rapid action which all these substances possess when

* Bromoform is a substance of great rarity, and by no means easy to make. Though mentioned in recent chemical works, the notice is very scanty and imperfect. Indeed, Mr. Bullock, to whose politeness I am indebted for what I used, informs me that, having tried the processes mentioned for its production, he found them unavailing, and that he was obliged to institute a series of new experiments before he could obtain sufficient for my purpose. I would here take the opportunity of presenting to Mr. Bullock my thanks for his politeness in preparing for me several of the agents used. Feeling certain that the hydriodic ether I had been supplied with was not pure, I requested Mr. Bullock to prepare me some, with other substances, of course, as a stranger, expecting to pay for them. Mr. Bullock not only prepared the agents for me, but presented them to me without charge. I am indebted to this gentleman for bromoform, benzole, hydriodic and hydrobromic ethers, bromide of olefiant gas, and for some of the chloride of this gas; though part of the Dutch liquid was prepared by Mr. Morson, and several ounces, which were sent by Messrs. Gale and Co., they have since informed me were obtained from Messrs. Heathfield and Burgess.

† I find that Dr. Snow states of bromoform,—"It boils at about 184° Fahr., but as its vapour is twice as heavy as that of chloroform, it is, in point of fact, nearly as volatile as that liquid." "On Narcotisms by the Inhalation of Vapours."—*Medical Gazette*, 1848.

In the latter part of this statement, at least, there is, I think, some error ; for if an equal quantity of bromoform and chloroform be dropped upon writing paper, the latter will be found to have disappeared within one-fourth of the time of the former.

so used, there being but little difference in the quickness with which they act, but also the very small quantity of each fluid which is sufficient to produce death. The symptoms preceding death, and the appearances presented afterwards, do not differ materially from those caused by inhalation. From these experiments it would appear that, as with inhalation, so with injection into the blood, chloroform is the most powerful and the most fatal, five minims being sufficient to induce unconsciousness and insensibility, but not death; ten minims destroyed, with every symptom of poisoning by hydrocyanic acid, both before and after death; whilst twenty minims almost instantly killed the dog, which was a large one. Twenty minims of sulphuric ether in one dog did not entirely destroy consciousness, but in another and larger dog, before the whole of thirty minims could be got into the veins, it was very powerfully affected, and shortly was dead. Acetic ether is quite as destructive; indeed, I believe, more so than sulphuric. The effect of injecting hydrocyanic acid into the veins may be seen in experiments No. 142 to No. 152, page 94 to 98, of the last volume of the *Transactions*.

Administration by the Alimentary Canal.—The experiments under this head, compared with others, are very interesting and important, as they prove most unequivocally that most, if not all, of these agents, when taken into the stomach or any portion of the alimentary canal, produce hardly any anæsthetic effect, acting at first as but little more than local irritants, unless the dose be very large; and even then, not producing so much effect as an equal quantity of spirit of wine. This is an effect which, *a priori*, hardly any one would have predicated, and which may assist in throwing some light upon their action, and evidently depends upon some property in the substance itself, inasmuch as we find a considerable difference in this respect amongst them. Some act very violently and most speedily when applied upon the alimentary membrane, but with much less effect when applied by inhalation upon the respiratory membrane, as conia and spirit of wine. Hydrocyanic acid acts with great intensity, administered by either method, while the ethers, chloroform, Dutch oil, bisulphuret of carbon, (and especially sulphuretted hydrogen,) produce, so to speak, hardly any effect when taken into the stomach, but very decided when inhaled. A comparison

of the experiments will show that where scarcely any effect has been produced when swallowed, a like quantity of the same substance when inhaled, even in the same animal, induced, not merely a complete state of anæsthesia, but death. Compare experiment No. 3 with 256, and No. 4 with 258; No. 13 with 259; 261 with 291. When given by means of a sponge, a good portion is blown away by the expired air, so that a less portion actually reaching the lungs produces a much greater effect than when swallowed.

Prolonged Inhalation.—It appeared to be a question of importance to ascertain for what space of time an animal may be kept under the influence of anæsthetic agents, life being safely maintained; whether the mere prolongation of that condition, which for a limited period may be borne with impunity, would be destructive of life; and if so, how long a time would be required to cause death, supposing the largeness of the dose itself were not the immediate cause; what, under such circumstances, are the appearances of the different organs? and whether any great difference exists between the different substances used in the time during which an animal may be with perfect impunity kept in a state of anæsthesia?

Though these experiments sufficiently prove that of these agents chloroform is amongst those which are the most speedily fatal, they also demonstrate that even with it life may be safely preserved, supposing ordinary care be taken not to carry the condition of insensibility too far, for a much longer period than can ever be requisite in surgical operations, or in prudent hands, in obstetric practice. As the post-mortem appearances will have to be referred to hereafter, it is needless to allude to them now.

Remedies.—Various remedies have been suggested as possessing a controlling power over the effects of too great a dose of ether and chloroform; as yet their advocates can only advance assertion, or arguments based on theoretical grounds, in favour of their respective favourite means. From some of these means upon which most stress has been laid, if my ideas of the action of ether and other anæsthetic agents be correct, little good can be effected; but, nevertheless, it was only right to give them a fair trial. The

remedies resorted to are ammonia, cold affusion, agitation, bleeding, galvanism, and oxygen; either alone, or in combination. In trying the effects of these, of course it was necessary to endeavour to bring the animal fully under the influence of the anæsthetic, otherwise by the mere cessation of the action of this, a natural resuscitation would ensue, and, possibly, value be attributed to the means tried to which it is not entitled. We will remark upon these plans *seriatim*.

Ammonia.—Experiments 283, 4, 5, 6 and 7 will show how far the value attributed to ammonia is just. In the first case it was administered in as large doses, and under as favourable circumstances as it is ever likely to be in practice, without any advantage whatever; even in two of the cases the anæsthesia was not excessive: while in the other two cases it was given by inhalation, mixed with the agent itself, the effects of which it is assumed to counteract, the result will show the fallacy of the notion; it possesses not the least controlling power over the effects. If, therefore, when given mixed with the agent, ammonia does not prevent its peculiar influence being exerted, it is not likely, when administered after this influence has been developed, to counteract it. Ammonia I regard as altogether valueless; indeed, I am not sure that the activity of chloroform and ethereal oil was not increased in the cases where they were given mixed with ammonia.*

The same experiments and others, distributed in other places, will show the effect of *cold effusion* and *agitation*. Both of these appear to me to possess more power than ammonia; indeed, they appear to be the only means which I have tried that do exert any influence, but to neither of them am I inclined to attribute any very great virtue. If the case be a bad one, the insensibility very profound, and the collapse suddenly produced, with suspension of the heart's action and of respiration, (and, be it observed, where these are not suspended the animal will generally recover, if left perfectly alone,) I do not think they will exercise much, if any, influence in preventing death from occurring. When an animal is slowly recovering, the return of consciousness and sensation being prolonged, and as it were halting, then cold affusion and agitation certainly do hasten the process, and the animal recovers

* This exactly corresponds with the opinion formed as to the value of ammonia as a remedy against the effects of an over dose of hydrocyanic acid. *Vide* experiments in the last volume of the *Transactions*.

both sensibility and motion sooner than when nothing is done; but, so far as I can form an opinion, I am doubtful if this be the case while the anæsthesia is profound, and consequently when the danger is the greatest. I am certain then great violence is not useful.

I do not think the cold douche should be prolonged, nor a large portion of the body be immersed; there is already great depression and coldness. The douche should be merely used to produce a sudden shock; hence I think a small quantity of cold water, suddenly dashed upon the face or chest, the parts being immediately dried, and the process repeated in quick succession a few times, is far more likely to be useful than a prolonged immersion of the body in a large quantity of water. For the same reason the agitation should be sharp and sudden, rather than long and violent. The two may be practised together; and it is a question whether the alternation of heat and cold might not be advantageous. I should be much disposed, between the intervals of dashing cold water upon the head and face, to apply a very hot flannel or cloth upon the chest, and at the same time to agitate the body.

Bleeding.—The three experiments, Nos. 288, 89 and 90, as well as No. 255, where the anæsthetic was injected directly into the circulating fluid, will show how completely fallacious is the opinion of the usefulness of venesection. As with hydrocyanic acid the circulation is suspended, hence no blood will flow. This suspension does not arise from an engorgement of the heart, owing to some mechanical obstruction to the passage of the blood from one side of the heart to the other, and a consequent inability of it to press forward its accumulated blood, but from a primary condition of the heart itself, so that if blood did flow from an open vein, no benefit would ensue; but inasmuch as the *vis a tergo* is almost or altogether annihilated, no blood does flow. Even on a large artery being divided, no blood escaped, none being propelled into it. The small size of the arterial pulse in an animal in a full state of anæsthesia, will show how feeble is the stream of blood which is propelled into the vessels. As animation returns, and the heart begins to act, blood will escape from the wounded vessel; but this is in consequence of the heart having acquired more power, and not that the heart's acquisition of power is the consequence of the opened blood-vessel, the only effect for which it would be practised. It is not meant to be denied, that in some cases venesection may

be useful, as when the heart is weak, by lessening the weight of the column of blood, and thus rendering its work lighter; but, on the other hand, the debilitating effect which the abstraction of blood has, must be considered. As a remedy, blood-letting is valueless, or nearly so, for removing the immediate and threatening condition; it may be useful in some few cases as a secondary means, but as a rule, when the case is urgent, it is useless, for blood will not flow; and where the case is not so urgent, and blood will flow, it also may be useless, or worse, for the case will recover without it.

Galvanism is a means which many would, *a priori*, be inclined to consider as likely to be efficacious. My experience of its total worthlessness in counteracting the effects of hydrocyanic acid had rendered me rather sceptical as to its utility; nevertheless, I gave it a full and fair trial in the three experiments Nos. 291, 2 and 3, which, I think, must be regarded as conclusive. It is true the muscles are made most vigorously to contract for a few minutes; but this only appears to excite and exhaust their contractile power more speedily, without in any way restoring their vital action. Galvanism may for a time supply the stimulus of, and usurp the place of volition, but if it simulates, it does not restore consciousness and sensation. It may be alleged that these animals were so completely brought under the influence of chloroform, that nothing could save them, and that death must, as a necessary consequence, ensue. The result certainly shows that death did ensue; but considering the comparatively small quantity of chloroform used, the short time it was inhaled, and the manner in which the experiments were conducted, I think we have a right to conclude that as little was given as could have been to render the trial a fair one. Many similar animals had recovered from far larger doses; and with less these creatures would have rallied without anything being done; not rallying with the galvanism, we may consider it as powerless, as a remedy.

Oxygen is the remedy which has been more frequently recommended, and its virtues extolled, than perhaps any other; with what truth, the experiments will show. It has been recommended in total ignorance of the action of chloroform and ether, (the two for which it has been proposed,) and hence the misconception of the part it is to perform.

In recommending several of the so-called remedies and antidotes,

one most important circumstance appears to have been altogether overlooked, namely, that in the cases where their employment is advised, there is no means of administering them. Deglution is destroyed, consequently fluids cannot easily or safely reach the stomach, and respiration has ceased, or nearly so, hence gaseous matters cannot be inhaled, even were they at hand; for the administrating such gases by artificial respiration would be very difficult and imperfect. This is supposing it were certain that they are as valuable as has been supposed, which I believe not to be the case. If oxygen, or any other gas is to act as an antidote, it must be by decomposing the chloroform or other agent in the lungs; but as oxygen does not decompose these fluids out of the body, it is not likely to do so within, even did these fluids remain any time in the lungs, which they do not. To act as a remedy, it must be either by directly destroying the action which the poison has occasioned, or by setting up an opposite action which shall counteract it. Now as we have no evidence that the action of chloroform and allied anæsthetics in any way depends upon the abstraction of oxygen from the blood or tissues, or prevents the exhalation of any noxious matter which the presence of oxygen favours, there is no reason to suppose the presence of this body will counteract or destroy the influence of them.

The opinion which appears fairly deducible from reasoning alone, is fully borne out by facts. So far as the experiments with oxygen go; they show it to be altogether useless; indeed, if any conclusion is to be drawn from them, it would rather be that oxygen, instead of being beneficial, is injurious. Experiment 297 shows that oxygen has no power to arrest, retard, or destroy the action of chloroform, even when inhaled with it; while Nos. 294, 5, 6, 8, and 9 show that the inhalation of oxygen, when anæsthesia had been produced by chloroform or sulphuric ether, so far from being beneficial, was injurious; or, to say the least, retarded resuscitation. From the comparative experiments, we see those animals, which were uncontrolled, recovered more quickly than those which were placed in an atmosphere of oxygen; and those which were placed in the oxygen appeared to rally immediately on coming into the open air, far more than while they were in the oxygen.

Local Action.—In the commencement of last year, while

engaged with these experiments, the idea was conceived that if these agents acted primarily upon the nerves, then possibly local insensibility might be induced, and thus, perhaps, the necessity for producing loss of consciousness might at least occasionally be avoided. Some time afterwards, when employing a frog, in putting some chloroform into the jar, a drop or two fell upon it; the pain which it at first apparently produced, and the greater loss of sensation in the part afterwards, seemed to point out these creatures as well adapted for pursuing the subject with; whereupon I made many experiments with frogs, toads, and newts, all of which are particularly susceptible to the local, as well as general action of anæsthetics; and subsequently also upon many other creatures, both higher and lower in the scale, as well as upon man, all of which confirmed, in the most undeniable manner, the truth of the opinion. The general fact I mentioned, and exhibited some experiments upon frogs and toads showing it, at the meeting of the Yorkshire Branch of the "Provincial Medical and Surgical Association," held at Leeds, in June last. A notice of this communication appeared in the journals and in *Braithwaite's Retrospect*, shortly after which, the fact was confirmed by Dr. Simpson, of Edinburgh, who published some very similar experiments, with the same result.

These experiments I regarded at the time, and still do, as more interesting and important in a physiological, than a pathological (so to speak) point of view, though they are not devoid of interest and use in this. The phenomena exhibited when a limb or portion of the body is exposed to any of these agents, I have alluded to at the commencement of the account of the local action, and also in giving the details of each experiment, and will not therefore repeat them here. Whether in operative surgery the local action of anæsthetics will be of much use, may be considered as doubtful. In many cases, as, for instance, lithotomy and deep-seated tumours, they could not be used, and in the larger amputations they would not penetrate to a sufficient depth to render the parts insensible throughout, unless applied for a very long time, and it is not unlikely during the long application, the system itself might be affected; besides which, there are many practical difficulties which would impede their use, and which it would not be easy to overcome, as the confining

the fluid, without evaporation, to the part wished. In the smaller operations they certainly may be used so as to induce complete local anæsthesia; and if there be any constitutional impediment contra-indicating the internal exhibition, as great susceptibility to their action, (as I have known in persons of a hysterical or cataleptic diathesis,) there the local action should be preferred; but in other cases it is doubtful, if the longer time required for their application, and the smarting, which, if there be any abrasion of the skin, is great, and if a wound of any extent, too great to inflict, which is occasioned, be worth undergoing for the sake of avoiding the inhalation; unless the part to be operated upon be small, I should say not.

There can, however, be no doubt that the local application of chloroform and other similar agents, in cases of severe pain, is often productive of the greatest comfort and relief. In painful and irritable tumours, the pain may often be alleviated. Tic doloreux I have seen disappear like magic, by rubbing the part with it, or saturating a piece of lint and covering it over with oiled silk. Toothache may often be charmed away by a drop put within the decayed tooth. Lumbago and sciatica may be quieted by its use, and in many other cases the local action of chloroform has been very successful in relieving pain, as, indeed, great numbers of medical men, who have since the announcement of its local action tried it with manifest advantage, can attest.

We may now proceed with the endeavour to answer, *seriatim*, the queries proposed at the commencement of this investigation:—

Question I.—*If the property of inducing anæsthesia be confined to the few substances which have hitherto been used, or if there be not a large class of bodies, which have in common the property of temporarily suspending consciousness, or sensibility, or both, vitality remaining; and if this be so, whether these substances are characterized by any similar composition or chemical alliance, and have a common modus operandi upon animal bodies?*

The experiments related in the foregoing pages prove, most unequivocally, that the power of temporarily suspending con-

sciousness and sensation, more or less completely, is not confined to the few substances which have hitherto almost exclusively been used for the purpose, but that many other substances possess this property in common with sulphuric ether and chloroform. Many in a less degree, some in an equal, a few in a greater, and, probably, there may be other substances in the various compounds of the ether and allied groups, which chemistry is almost daily adding to the list, that may be discovered to possess the power in a still greater degree. To this part of the proposition an answer may, without hesitation, be returned in the affirmative.

To the second part of the proposition, in the remarks appended to each substance, a partial answer has been given. Those who will take the trouble to refer to them, and to go over the details of the experiments upon which they are founded, will be able to judge for themselves as to how far the conclusion that these substances are so characterized is correct. If those bodies are excluded from our consideration which do not appear, though they may induce insensibility, to produce that condition of the system which is understood by the term anæsthesia, as the protoxide of nitrogen and sulphuretted hydrogen, the other substances experimented upon may be arranged into three classes, according to the number of elements which enter into their composition :—

1. The quarternary, into which, besides carbon, hydrogen, and oxygen, one other element enters, as nitric ether; these are very few in number, and not remarkable for anæsthetic power.

2. The ternary compounds, which are far more numerous and powerful. They all agree in having carbon and hydrogen entering into their composition, while the third element is very varied. In the oleum æthereum, in aldehyde, in sulphuric and acetic ethers, it is oxygen; in chloric and hydrochloric ethers, in chloroform and chloride of olefiant gas, it is chlorine; in hydriodic ether, (iodide of ethyle,) it is iodine; in hydrobromic ether, (bromide of ethyle,) bromoform, and bromide of olefiant gas, it is bromine; while in hydrocyanic acid, the third element is nitrogen. Moreover, of this third element, even when the same, the relative proportions may vary considerably, the anæsthetic power of the substance remaining very great; for instance, in the atom of chloroform there are three of chlorine, whereas, in the atom of chloride of olefiant gas, there are only two atoms, while the proportion of

carbon and hydrogen are much greater in the latter substance than in chloroform.

It is worthy of remark, that in all these bodies, with one exception, the carbon and hydrogen may be considered as forming a radical base, which unites with the oxygen, chlorine, iodine, and bromine, to constitute a neutral body, or, as we shall presently mention, to act as a base for another combination. In hydrocyanic acid the base would appear to be formed of carbon and nitrogen, the hydrogen in this playing the part of an acidifier, the resulting compound being the feeblest and most unstable of all acids. This slight acidity can, however, be scarcely considered as a distinguishing character; for we find that conia and other similar vegetable proximate principles, where the same three elements constitute the substance, have a feeble alkaline action, the different character of these bodies depending, probably, rather upon the amount of nitrogen than of the hydrogen.

3. In the third group the substances are all bi-elementary; they are, with three exceptions, hydrocarbons, the exceptions being carbonic oxide, bisulphuret of carbon, and chloride of carbon.

The most simple, obvious, and striking physical properties which the whole of these substances possess in common, is that of being gaseous, or of being so volatile that at the ordinary temperature they are readily converted into vapour.

Although in the first group, that of quarternary compounds, the number of substances is limited, there are several of those which, on ultimate analysis, are found to consist of only three elements, which most probably, in mode of combination, have a strong analogy, if not identity, with this group. For instance, acetic ether, although only containing hydrogen, carbon, and oxygen, has probably these elements arranged, in the first instance, so as to constitute oxide of ethyle and acetic acid, which as such, then enter into combination with each other to form acetic ether, as the nitric acid and oxide of ethyle do; this also may, perhaps, be the case with hydrochloric ether. Thus I should take these bodies as illustrations of the correctness of the doctrine which I have before suggested, as to the theory of substitutions. For this also, we may refer to the second group, where we find the chlorine may be withdrawn, and iodine or bromine substituted; that is, always provided the substances, if not absolutely

isomorphous, are at the least possessed of corresponding forms; otherwise their action will not be similar, and one element cannot then be substituted for another, as in the instance of iodoform, which, so far as the number of atoms goes, is identical with chloroform; yet the one being a fixed, solid chyrstalline body, the other a very volatile fluid, they do not possess physiological action, any more than physical properties in common.

If we analyse the composition, and compare the effects of each of the substances in the second group, we find that we may in succession exclude the third element of which each consists, and yet have an effective anæsthetic: thus in sulphuric ether, we have oxygen, but no chlorine or nitrogen; in chloroform, chloride of carbon, and chloride of olefiant gas, no oxygen or nitrogen, but chlorine instead; in hydriodic ether, iodine; in bromoform and bromide of olefiant gas, bromine is substituted; while in hydrocyanic acid, we have neither oxygen nor chlorine, but nitrogen; so that by this process alone, we should come to the conclusion that however advantageous one or other of these third substances may be in modifying the action of the other two elements (the hydrogen and carbon,) of which the agent consists, they cannot be regarded as at all essential to the constitution of an anæsthetic body. This conclusion is rendered perfectly certain, when the constitution and action of the third group of substances is considered. Here most of the substances only consist of hydrogen and carbon, and yet among them are found agents which are possessed of considerable anæsthetic power, as for instance, benzole, common coal gas, and olefiant gas.

In attempting to carry the analysis further, and ascertain if one only of these two elements possesses the property, there is considerable difficulty, in consequence of the impossibility of presenting carbon in an uncombined form; we therefore must adopt another method, that of combining it with other bodies; and, for the sake of comparison, the same must be done with hydrogen also. Hydrogen, if given alone, does not possess any anæsthetic property whatever, and if given in combination with any other body than carbon, it certainly does not act as an anæsthetic. With oxygen, it is perfectly inactive; with most other elements, it becomes a deadly poison; with chlorine as hydrochloric acid; with sulphur, phosphorus and arsenic, as

sulphuretted hydrogen, phosphuretted hydrogen, and arsenicated hydrogen, these latter being amongst the most violent poisons known. On the other hand, if other combinations of carbon are employed, as the bisulphuret of carbon, carbonic oxide, and chloride of carbon, it is found that these substances do act as anæsthetics; some of them not so safely, pleasantly, or so manageably, it is true, being altered and modified by the other substance with which the carbon is combined; but, nevertheless, still acting as anæsthetics. Hence, I think, we may legitimately arrive at the conclusion, that to constitute an anæsthetic agent, carbon must be present, and that by the combination of it with hydrogen, (or perhaps chlorine,) we have the basis of the most effective anæsthetic agents. Whether the hydrogen itself plays any important part or not, it is difficult to say with certainty; probably it does, for though, *per se*, it appears to be absolutely negative, yet, as in combination with sulphur, it materially modifies the action of this, as see the different effects of sulphur in combination with hydrogen and with carbon, and the excessive virulence of phosphuretted and arsenicated hydrogen; so we may also suppose it to modify the action of carbon when in combination with it, and thus that it plays an important part.

This view, I am inclined to think, is much strengthened by the fact, that the proportion in which these two substances are combined with each other, appears to materially alter the powers of the compound; whether the two are given alone as a pure hydrocarbon, or in combination with a third body; for the greater the proportion of carbon, the more powerful is the action of the substance. Thus the light carburetted hydrogen does not at all equal in power the heavy gas; and a careful examination of the constitution of the triple substances will show that those which possess the largest proportion of carbon, also exercise the most energetic action. Here, however, very great care must be exercised in discriminating between the effect of the hydrocarbon base, and the proper action of the third element with which it enters into combination; thus nitrogen renders it highly inimical to life, as witness the effect of hydrocyanic acid. The difference in the action of oxygen and chlorine may be seen in the effect of the two corresponding preparations, sulphuric and hydrochloric ether; the one being an oxide of ethyle, C_4H_5O, the other a

chloride of ethyle, C_4H_5C. While the difference made in the action of the hydrocarbon in combination with the same third element, by an alteration in the proportions of this third element, may be seen in the different effects of the oxide of ethyle, (ether,) and the hydrate of the oxide, (alcohol); the only difference being that in the latter there is an addition of an atom of oxygen and hydrogen, the effect, however, being to reduce the power of this as an anæsthetic almost to zero. As regards chlorine, the action of chloroform and the chloride of olefiant gas may be compared, the former containing three atoms of chlorine, with less carbon and hydrogen than the latter does with two atoms of chlorine; the action of the chloride of olefiant gas being as an anæsthetic quite as, if not more potent, while it is more manageable, in consequence of not being so depressing, arising, I suspect, from the less amount of chlorine itself.

We may therefore, to recapitulate, conclude:—

1. That no anæsthetic substance has yet been discovered which does not contain *carbon*.

2. That the combination of carbon with hydrogen or chlorine constitutes the best binary agent, and that the greater the proportion of the carbon to the hydrogen, being at least equal to it, the more powerful the agent is; and if we could obtain a pure liquid of hydrocarbon, containing these equal proportions, easy to be volatilized, and of constant composition, it is highly probable that it would constitute a valuable and safe anæsthetic; for if the carbon be too much in excess, as in benzole, where the proportions are as two of carbon to one of hydrogen, although the compound is a powerful and safe anæsthetic, yet it is neither so manageable nor pleasant as where the proportions of carbon is not so great, symptoms being developed which may reasonably be supposed to arise from the excess of carbon.

3. That hydrogen and carbon may unite, as a radical base, with oxygen, chlorine, iodine, bromine, nitrogen, and perhaps some other substances, to constitute anæsthetic agents; and that these compounds, or at least some of them, may again unite with acids, consisting perhaps of the same elements as the base itself, and yet retain, to a certain extent, the same property as the oxide of ethyle; as nitric, chloric, acetic, and hydrochloric ethers do.

4. That of these ternary compounds, those act the best, all

things taken into consideration, in which the third element bears the least proportion to the hydrocarbon, especially the carbon; as, for instance, ether and alcohol, perchloride of formyle, (chloroform,) and hydrochlorate of the chloride of acetyle, (Dutch liquid,) and of the binary compounds, those in which the atoms are in equal proportion to each other.

5. That substances which are analogous in composition and isomorphous in form, as in physical and chemical character, so are they often similar in physiological action; but where they are not isomorphous, their action is not similar, as chloroform and iodoform.

6. That substances which are isomeric, or nearly so, but very dissimilar in physical and chemical properties, are also so in physiological, as witness several of the pure hydrocarbons, which, though very similar in composition, are very different in properties.

7. That should any other combination of elements be discovered which shall possess more valuable and important anæsthetic power than those yet known, its composition will probably be found in accordance with the principles now announced.

Lastly. We may conclude that the action upon the animal economy of all true anæsthetic agents, whether carbons or hydrocarbons, whether simple or combined, is essentially the same in character.

QUESTION II.—*What is the modus operandi of anæsthetic substances? In other words, upon what structures do they act? What changes do they produce? What are their physiological effects? Is their primary effect local or general?*

This question is by no means of very easy answer; probably no reply will be considered by everybody as satisfactory and conclusive. In giving the opinion I do as to the *modus operandi* of anæsthetic substances, I am not insensible to the difficulty and intricacy of the subject. The reply is one that must strictly be founded upon observation. Not only must all the effects during life be carefully watched, but the post-mortem appearances in the bodies of animals (and, unfortunately, as has too often happened of persons,) destroyed by these agents, must be

attentively examined and compared. The number of animals destroyed in the course of this investigation has been large, not only for the purpose of ascertaining the quantity of these agents respectively, which would, as a general rule, destroy life, but also for the purpose of examining the effects produced upon the different organs by them. The details are carefully given in each experiment, and for the particulars in each case, reference must be made to the report. Another element not to be overlooked, in forming an opinion as to the action of these agents, is the varied effect according to the different manner in which they may be presented to the system.

I am inclined to think the action is primarily in all cases, and principally, if not entirely, upon the nerves; and further, that it is upon the peripheral extremities of these that the direct effect mainly occurs. As this opinion differs materially from that of other gentlemen who have paid much attention to the matter, it will be necessary to state the reasons which have lead to its adoption.

When one of these bodies is applied in substance, or in vapour, to the skin, and evaporation is prevented, the first sensation is that of warmth; smarting and pain soon follow, and with these generally redness and some swelling. After a time the pain ceases, when numbness and loss of sensation ensue: if the application be some time longer continued, most distinctly and unmistakeably these proceed along the course of the nerves far beyond the part with which the agent is, or has been, in contact; and in the instance in which I had retained my little finger for some time in a small jar containing twenty minims of Dutch oil, a tingling sensation, with a feeling of numbness, were clearly perceptible along the inner side of the ring finger, but not along the radial side.

When applied upon the tongue, swallowed, or injected into the rectum of animals, (see Nos. 256 to 274,) the same irritant effect is produced. If chloroform be allowed to come into contact with the lips or face when inhaling it, everybody knows it is apt to blister the thin skin. The effect of those whose sedative power is not very great, when an animal is placed in their vapour, is that of a prolonged irritant upon the conjunctiva and Schniederian membrane, with some even upon the bronchial membrane; with

those agents whose sedative power is considerable, this appears to come on almost immediately; but even with some, as sulphuric ether, for instance, whose anæsthetic power is subsequently very considerable, the first effect is often greatly to irritate the bronchial membrane. These are facts which show these substances act, at any rate in the first instances, upon the nerves, precisely as other substances which are regarded as simple irritants do. This, then, may be regarded as their first action.

The effects upon respiration, the blood, the heart, and circulation are, I consider, only secondary; I do not think the blood is poisoned, (with the few exceptions mentioned,) or that its organization is materially altered. There are many facts to lead to this opinion. The blood does not lose its power of coagulating, nor is that which is taken from an animal in so complete a state of anæsthesia as to be presently fatal, or even immediately after death has been occasioned, when examined under the microscope, seen to be much, if at all, altered in its characters; consequently neither the fibrin nor the globules can be much changed. Unless the anæsthesia be very profound or prolonged, the blood does not vary much in its colour. That which flows from a wound during an operation is as bright as usual.* True, after death from these agents, the blood in the heart and large veins is often found to be of a darker colour than natural, but with many agents, as carburetted hydrogen, the contrary is the case, the blood is decidedly brighter than natural in its hue, and with most, if not all, that which is the most immediately in contact with the substance itself is so; for if there be one appearance more constant than another, it is the crimson or scarlet colour of the lungs. Moreover, even with chloroform and ether, the blood is not invariably dark; and when it is, usually, though not invariably, that within the left side of the heart is not so dark as that within the right, which, considering that it is it

* This at least is the case with chloroform and Dutch liquid, unless the anæsthesia be very profound, or much prolonged. I think, with sulphuric ether, possibly the blood is rendered rather darker than normal, though on my asking two gentlemen, who had seen as many operations performed upon persons in a state of anæsthesia as most parties have, if they had noticed any change in the appearance of the blood, said they had not, which they certainly would have done had there been any decided alteration. Several of the experiments show the blood to have been florid in colour.

which has just passed through the capillaries of the lungs, where, of course having been exposed to the full action of the agent, it will contain more of it than that on the right side, and consequently, if the change in the appearance of the blood depended simply upon the presence of the anæsthetic agent, this change ought to be the greatest on the left side, which is not the case. It might be asked, in how many instances after death by ordinary diseases, is the blood found otherwise than altered from that which is regarded as its normal condition, without the cause of death being for a moment attributed to the altered state of the blood itself? That the mere alteration in the colour of the blood is not essentially connected with the anæsthesia is evident from the effects of carbonic oxide, and some at least of the hydrocarbons, when the blood is of a brighter and more scarlet hue than natural. Hence the change in it is not uniform.

The mere suspension of respiration may of itself account for the darker colour of the blood. Some of the substances, if not in excess, may be added to the blood, external to the body, without inducing any change; and, further, we know they not only may be, but actually are, absorbed into it, and circulated with it, being either decomposed and carried off as carbonic acid and water,—burnt, or, as with ether, gradually exhaled with the breath for some time afterwards. Moreover, the almost instantaneous manner in which anæsthesia passes off, is altogether incompatable with the idea of the blood being altered materially. Were the effects dependant upon an alteration in the blood, they must necessarily be more permanent; neither should we have the sudden and complete restoration of the faculties, nor the healthy reparative processes usually so well and quickly developed after operations undergone when under the influence of anæsthetics. Long inhalation will sometimes produce a greater alteration in the character of the blood, as see experiments Nos. 276 and 9; but here, for hours, the action of the cerebro-spinal axis was almost suspended; certainly, to some extent, that of the ganglionic system was interfered with; the circulation was most imperfect, and respiration still more inefficiently performed, the influence of which must, in forming an opinion, not be overlooked. I do not deny that these agents are absorbed into the blood; on the contrary, I believe them to be absorbed, but I do not believe the precise amount

of their absorption is the direct measure of their effect, nor that their mere presence in the blood is the cause of it. If they be in the blood, of course they will act upon the susceptible lining membrane of the blood-vessels, and be carried to every part of the body; but I do not admit that they act by changing the organization or character of the blood; neither do I think to produce a given effect the blood must be proportionally, according to the respective volatility and solubility of the substances, saturated with each in an equal degree; on the contrary, I believe the effects will, *cæteris paribus*, depend upon the suddenness with which a given quantity is brought into contact with a large nervous surface. Thus a small quantity suddenly thrown upon the bronchial membrane will act far more energetically than a larger presented to it more slowly; and a few drops of chloroform or ether injected into the blood-vessels will induce far different symptoms from what, according to the calculations of their respective solubility in the blood, they ought to do, if the symptoms merely depended upon the absolute quantity actually in the blood, as compared with what it will dissolve.

The persistence, for days, of the partial loss of sensation and motive power in a finger which has been immersed in an anæsthetic substance, (as I have had in my own finger,) is altogether opposed to the doctrine of saturation of the blood. During this time the blood had been changed many scores of times, yet the effect remained confined to the part; and what is curious, I have sometimes observed it intermittent, returning for four or five evenings, (corresponding with the time of immersion,) far more perceptibly than in the intermediate periods. The fact of the disposition of the posterior extremities to be more or longer affected than the anterior, has often been noticed, as in Nos. 9, 213, 256, 260, 267, 271, 363. The ready manner in which one limb of an animal may be paralyzed by the local action, and experiments Nos. 318 to 325, in which it is shown that by several, if not all, of these substances, that the entire anterior or posterior half of the newt may be rendered motionless and senseless, the other half of the creature not being so, all point to the nerves as the parts immediately influenced. So also does the fact so often seen in the local action upon frogs, where, if one hind leg be immersed in any of these fluids for a few minutes, the corresponding

extremity will become affected before the other portions of the body are. While the excitement which an additional dose of the agent, given to an animal already to some extent under the influence of a previous one of the same or another agent, *instantly* produces, is inexplicable on the supposition of mere proportionate saturation of the blood, but perfectly so on that of their acting primary as irritants upon the nerves. (See experiments No. 275 to 282, especially 278, 312, and 318.)

Another argument, which is of considerable importance against the opinion that the degree of anæsthesia depends alone upon the degree of saturation of the blood, may be derived from No. 144, in which the pregnant cat was destroyed. Though the animal was evidently fully under the influence of the aldehyde, and, consequently, the blood must have been saturated to its full capacity, yet the fœtal hearts continued to pulsate even after the body of the mother had been laid open and they were removed from her. On the supposition of the blood being saturated, these ought, by having the maternal blood carried to them, to have been paralyzed, if not consentaneously, at least within a short period of her own heart ceasing to act; whereas, on the supposition of the action of anæsthetic substances being primarily upon the nerves, inasmuch as those in the fœtus are distinct from the mother, and the action of the fœtal heart depending upon the integrity of its own nerves, the continued action of it is easily explained.

It may be alleged that either the heart is primarily affected, or that the blood is prevented circulating in the lungs, owing to the congestion of their capillaries and consequent engorgement of the right side of the heart, from the same cause as occurs in drowning and poisoning by carbonic acid. A cursory glance at the condition of the heart in *post-mortem* examinations may possibly be thought to support this idea. In most cases the heart is to some extent filled, and the large veins are also engorged, but I do not think a more minute and correct examination will support the opinion. Were this so, the right side of the heart exclusively ought to be loaded, the left side to be empty. This is not so; for though the left ventricle often contains but little blood, the left auricle generally contains some blood, not unfrequently a great deal. Moreover, though the lungs are frequently scarlet or crimson in colour, this appearance differs materially

from the condition of these organs in asphyxia, where the dark carbonized state of the blood is thought to act as an impediment to its passage through the capillaries. Here the blood is in a contrary condition, and though, from the intensity in colour, the lungs are frequently spoken of as greatly congested, it admits of doubt if they are really much fuller of blood than in a natural condition; and the great collapse so frequently mentioned as occuring in the lungs, when the parieties of the chest are opened, shows there cannot be much distention of their vessels or structure. Besides, if the heart were primarily affected, it ought to be the organ whose action is the first to be suspended; whereas, the reverse is the case. The muscles of voluntary motion cease to act first, the movements of the heart continuing long after all action has been suspended or destroyed in them. True, but a feeble stream of blood is propelled, and in extreme anæsthesia none whatever; but still the heart moves longer than any other part of the body (unless, perhaps, the intestinal periastaltic action.)

The condition of the heart will be found to vary much, according to the suddenness with which the anæsthesia has been induced. If this has been slow and gradual, there will be comparatively little or no engorgement of the heart; but if it has been rapidly produced, and the examination be made *immediately* after death, the heart will be found to be completely loaded and distended, as, I believe, from the sudden suppression of the nervous energy, allowing the blood to continue to be poured into it without there being any perception of its presence, and hence, without any contractile power of resistance.

Anæsthetic agents appear to act more immediately upon the nerves of voluntary motion and sensation than upon the ganglionic system, hence the functions of the parts to which they are distributed become first suspended or destroyed; and if the action be too intense, then those parts under the more immediate control of the ganglionic system of nerves lose their action. The great length of time an animal may be kept in a state of anæsthesia, with hardly any power in the voluntary muscles, the heart continuing to act with tolerable regularity, confirms this view.

When speaking of the effects of hydrocyanic acid,* I had

* *Transactions of the Provincial Medical and Surgical Association* for 1847, p. 77, *et passim.*

occasion to mention the varied conditions of the heart, according to the suddenness of the death, especially the contracted state of the left ventricle, when death had been speedy. To these experiments and observations I would venture to refer. The effects being in many respects very similar to those of anæsthetic agents, they serve mutually to illustrate the action of each other. The fact of the great distention of the right side of the heart, with the frequent contraction of the left ventricle, when death had been suddenly induced, and the examination made very shortly after death, was particularly pointed out; but I was then at a loss satisfactorily to account for the fact. This, I now think, may be explained on general principles. I presume the natural condition of all the muscles, when first withdrawn from the control of the nerves, is one of contractility, (tonicity of the older physiologists,) as seen in the ordinary post-mortem rigidity. Thus when the nervous influence is suddenly and almost instantaneously suspended, the left ventricle remains in a condition of persistent contraction, which it will naturally do much more so than the right, being so much the more muscular of the two, besides not having anything to conduce to its diastolic action. The right side of the heart having ceased, or nearly so, to propel any blood through the lungs, there is no *vis a tergo* pressing upon the left ventricle, whereas the right auricle and ventricle are, to a great degree, under this influence; indeed possibly, though the pressure of the left ventricle through the capillaries is suspended, to a greater extent than in their ordinary condition. The fluid blood in the enlarged venæ cavæ will press into and tend to dilate the already engorged right side; and, in accordance with an hydrostatic law, that in proportion to the size of the area of the bottom of a column of fluid, so will be the pressure upon the sides of the retaining structure, it is evident this weakened and distended condition of the heart itself materially increases the pressure upon its cavities, at the very time when the feebleness of its walls can afford the least resistance. That this pressure upon the walls of the right side of the heart is too great to be overcome in such a condition of things, may be easily seen by opening the body of an animal in this state, when the right cavities are found in motion, not unfrequently actively so, yet they are unable to propel forwards the blood within

them; but if the pulmonary artery be opened, and thus an easy exit be afforded, the blood will flow as the contractions take place. Should the left side happen to contain blood, as it will do if death has not been so very speedy, the same phenomena are seen. If, however, the post-mortem examination has been delayed for twenty-four or forty-eight hours, the heart will not be found in this condition. The left side may not be found so firmly contracted, and the right side will generally not be greatly distended; at times, not at all. The right side of the heart partaking of the general post-mortem rigidity, (generally also the horizontal position of the body, by removing the perpendicular column of blood in the veins, takes off the pressure upon it, and hence favours the process,) gradually contracts, and presses out the blood; the degree of which will, among other things, depend upon the quickness with which coagulation takes place, and the firmness of the coagulum, which, in these circumstances, is not usually considerable. The large size of the heart, and the firmness of its contraction in men, who in the full vigour of health have suddenly been deprived of life, has often been noticed, and led some to think there has been an actual hypertophy of this organ. This sort of spasmodic action disappears in a comparatively short period after death, so that if the examination has been delayed for the period just indicated, the left side has lost its great firmness, and the contrast between the two sides is not so remarkable as immediately after death. This view of the difference in the condition, as to dilation or not in the heart, is confirmed by the examination of that of the kitten destroyed by the prolonged inhalation of benzole, No. 282, in which the change was actually *seen* to take place in the exposed heart; also in 281 and many others, the different condition of the heart immediately, and some hours after death, is noted.

It may be proper here to call attention to the condition of the right side of the heart in two of the animals destroyed by hydriodic ether, in which air was found in it (Nos. 91 and 92.) In one of these it appeared possible that the air had entered the axillary vein in making the examination; but of this I am not sure. There was an escape of blood as the vein was opened; immediately air-globules were seen mingled with it, but whether these escaped with the blood, or became mixed with it in rushing

into the veins, I cannot say. Probably the air escaped from the vein, as in the quiescent state after death there would not be the same indrawing force—the dilatation of the heart and the consequent vacuum in the vein—at work as during life. There is no reason to suppose, in the second instance, the air found its entrance during the post-mortem examination; if it did, it must have been through a small cutaneous vein, as no large one was opened until the heart had been examined. Air is reported to have been found in the examination of one or two fatal instances from chloroform in the human subject, as in the case at Boulogne, where however, it has been attributed to the air entering a vein divided during the operation; but, considering the situation and small extent of the incision, this does not appear at all probable.

The condition of the muscles in an animal, after a strong dose of any anæsthetic agent, more especially chloroform and hydrocyanic acid, affords much support to the view now advanced as to their action. There is excessive weakness and loss of control. It is evident the stimulus to their contraction is wanting. The animal is often conscious long before there is any muscular power, or even much sensation (see Nos. 7, 9, 82, 170, 180, 212, 216, 239, and others); indeed, after a moderate dose, or when the dose is not sufficient to induce a complete state of anæsthesia, consciousness remains when there is no power of motion, and but little sensation, as everybody who has inhaled any of these substances knows. The return of muscular power is often accompanied by convulsions, which sometimes are very violent and prolonged, as in Nos. 11, 13, 143, 169, 215, 238, 239, and others. In No. 323, as the frog recovered from apparent death, after exposure to the vapour of benzole, the movements in its limbs more resembled those induced by galvanism in an animal just dead than anything else. When in some degree restored, it is very irregular, and there is a great want of control over the movements, the animal going staggering and rolling about. When the hand is laid upon the limbs, the muscular fasciculæ often may be felt quivering in a rapid manner, with a sort of vermicular motion. There is always a loss of heat, the vital powers are evidently depressed, the animals are all cold, and for a time appear shrunk. The strong resemblance of these phenomena

to those exhibited in an unseasoned man recovering from a very drunken bout, occasioned by a large quantity of ardent spirits, cannot fail to be at once perceived.

The almost total absence of any unnatural appearance in the central nervous mass in animals which have been destroyed by these agents is very remarkable. As a general rule, there is neither effusion nor any considerable congestion,* being, as I believe, another evidence of the brain not being affected by the changed condition of the blood, or the altered character of the circulation. After death, from the directly narcotic poisons, (as, for instance, conia, Nos. 219, 220, 221, or asphyxia,) great cerebral congestion is found. This appears further to show that the action of these substances is not directly nor primarily upon the nervous centres, but upon the extremities of the nerves inducing a change in their action, which is propagated along their trunks to the spinal marrow, medulla oblongata, cerebellum, and hemispheres of the cerebrum; complete anæsthesia being caused when all these portions are involved.† We may, then conclude :—

1. That the action of anæsthetic agents is immediately and

* In several of the animals whose heads were opened immediately the vital functions ceased, a serous condition of the brain is noticed. How far this may be abnormal is uncertain: that some, and probably to some extent a varying quantity of, serum is always present, seems certain; and we lack immediate post-mortem examinations after death, from other causes sufficiently numerous, to feel sure what quantity may be natural and what unnatural.

† I would venture to refer to the following passage from the Essay before mentioned, which was written three years ago, before any knowledge was possessed of anæsthetic bodies:—"Though the sensorium is soon affected, as shown by the vertigo, which is one of the earliest symptoms, it is not that portion of the cerebro-spinal axis which appears to be most affected by hydrocyanic acid. At the time I was with Mr. A——, I could not divest myself of the feeling that he retained some degree of consciousness, and was, to some extent, cognizant, at least in part, of what was going on about him, (and even at first, when I shouted in his ear, that he recognized my voice,) at a time when he was unable to give much indication of sensibility. From what I have since seen in many of the animals I have experimented upon, I have little doubt they retain some consciousness and sensibility, when, from the powerlessness of the muscles, they are unable to indicate it. Of course, when the powerlessness is complete, it cannot be proved that either, in any feeble degree, is retained.

"To what extent consciousness is retained it is difficult to say. I am, however, inclined to think it is preserved to a longer period than many are even now disposed to allow. The many cases which have been reported, where parties have swallowed large doses of hydrocyannic acid, and yet retained consciousness for some time,

primarily upon the nerves. That the heart, respiration, circulation, the blood, and the muscles are secondarily affected.

2. That in the first instance all these substances act as stimulants, this action being more or less prolonged, but to some extent perceptible in all. In the more powerful anæsthetics, as hydrocyanic acid, chloroform, and the chloride of olefiant gas, the stage of stimulation is short and comparatively feeble, (unless with the two latter the dose be very small, when it is evident enough,) the sedative effect being quickly superinduced. With most of the others it is more prolonged; with ether it is considerable; with aldehyde it is still more so; with the bisulphuret of carbon, turpentine, and naphtha, even when inhaled, it is very great, and when applied locally, intense inflammation only is induced, anæsthesia scarcely being occasioned; while with alcohol, even when taken internally, unless the quantity be enormous, only the stimulant effect is produced at all.‡

proves that it may be retained longer than was formerly supposed to be possible; but, even in these, consciousness is thought to be retained only so long as the power of voluntary motion continues. It, however, appears in some cases, where either the dose has not been sufficiently large to prove suddenly fatal, or the susceptibility of the animal to its action but little, that some degree of consciousness may be retained after all power of voluntary motion is lost, and even where there is but little sensibility remaining; at least, some of the foregoing experiments seem to indicate this. If this be correct, it would prove that the sensorium is not that part of the nervous system which is most affected by hydrocyanic acid; so also the violent spasmodic action, occurring alternately with paralysis, independent of volition, would point rather to the spinal marrow than to the brain, as being most obnoxious to the action of the poison. * * * * Reflex action is that which is last destroyed, and first returns; this continues some time after all voluntary motion and sensation have ceased. Touching of the cornea will induce winking of the eyelid when there is nothing to indicate the retention of volition or sensation, and irritating the nostrils of a frog will cause depression of the eye."—*Transactions of the Provincial Medical and Surgical Association* for 1847, page 74, *et seq.*

In this quotation is clearly mentioned the same phenomena which result from a dose of ether. On the very first announcement of the effect of ether, I immediately saw the connection in their action, and would refer to experiments Nos. 87, 87*, and 87**, page 34, and to the passage at page 89, where, in speaking of the effect of ether, which had been thought to be a *remedy* against the effects of hydrocyanic acid, it is said,—" So far from any benefit resulting from it, *if any effects were produced by it, the action of the acid was increased in power and rapidity.*" As showing how nearly an important discovery may be approached without being actually achieved, the fact was observed and mentioned, but not the practical inferences deduced.

‡ Most practitioners will, however, call to mind more than one instance where patients, upon whom a large cloth soaked in turpentine has been applied, have kept

3. That the action is at first local. When these agents in substance or in vapour are applied to a limited portion of the body only, that portion is rendered anæsthetic; but that if the application be more prolonged, or extended over a larger surface, then the effects become general. Thus we may paralyse a part, or the whole of a single leg in the frog and toad; by continuing the application, the corresponding limb becomes involved, and a still farther continuation will affect the entire body of the creature, consciousness, sensation, and motion being all lost. In a a large insect, or a reptile, we may stupify the anterior or posterior half of the body with the attached limbs, the other part remaining unaffected. Even with the higher animals, the experiments demonstrate that, in the cat and rabbit, a part of a leg may be locally so affected as to be altogether insensible to the amputation of it, the general system not differing from its normal condition. In man, a small portion of the surface, or an entire finger, may be made insensible, the feeling of numbness extending along the nervous trunks far beyond the part to which the application is made. Hence we may fairly conclude that the law universally holds good.

4. That although the action of anæsthetic substances is upon the nerves, and principally upon those in connection with the cerebro-spinal axis, it is not primarily and directly upon the cerebral masses and sensorium, but upon the peripheral expansions of the nerves; that, *cæteris paribus*, the larger the number of these which can be directly and simultaneously acted upon, the greater will be the effect. Hence the *rationale* of the action of these substances when inhaled. When taken in substance into the stomach, they can only come in contact with a comparatively small number of terminal nervous papillæ, whereby is occasioned their stimulant, rather than their anæsthetic effect; but when inhaled, they come into contact with the whole expanded respiratory surface and the nerves there exposed. Of course the more concentrated the vapour, the more intense and sudden will be the anæsthetic effect.

it on much longer than was intended. Having borne the stimulant and smarting effect, the sedative has followed, during which they have fallen asleep, an effect which more frequently happens when a large turpentine epithem is used than when a small one; the apparent contradiction of which is readily explained by regarding turpentine as one of the group of substances now under consideration.

QUESTION III.—*Is there any one of these substances which should be selected in preference to, or to the exclusion of, all the others? Is there any one, the temporary effects of which are more complete and certain, the permanent more harmless, and its administration more under our control than those of any of the others, that we should uniformly retain the employment of it, and reject the use of them?*

By far the greater number of the substances which have been tried, even of those which have been shewn to be capable of producing anæsthesia, may be dismissed without much comment; for though valuable in a scientific point of view, as tending to elucidate the physiological action of these bodies as a class, practically they are not of importance, as they are not likely to be employed while we are in possession of so much better. The substances which appear to possess the greatest power, and the effects of which are the least objectionable, are the oxide of ethyle, (sulphuric ether,) the gaseous carburetted hydrogens, (of which common coal gas is perhaps the best,) chloric ether, hydrobromic ether, chloroform, the chloride of olefiant gas, and the chloride of carbon.

Ether, which, from being the first substance of this kind introduced, was for some time almost exclusively used, has now almost ceased to be employed. In power, it certainly is much inferior to several of the other bodies; its action is not uniform and certain; more excitement is frequently manifested in its use; it produces much more irritation while being inhaled, and afterwards headache and feverishness are more liable to follow. These are objections so weighty, although in some degree counterbalanced by its general safety and the less liability to collapse supervening, that, unless under the circumstances pointed out in the remarks upon this fluid, and other anæsthetics are not at hand, it will hereafter, I apprehend, be rarely used.

Common coal gas is a safe and effective agent. Its cheapness is also an important recommendation. On the other hand, the disagreeableness of its odour, as compared with the pleasantness of the chlorides, and its gaseous form, especially the latter, are serious impediments to its general employment. Under any circumstances, the inhalation of a gas is not of so easy and convenient

accomplishment as that of the vapour of an easy evapourable fluid, more complicated apparatus being requisite. In places where the gas is not used for domestic purposes, the inconveniences of transporting and preserving it would be found to be objections not to be despised; but where other agents are not at hand, or from any circumstances are not thought to be altogether applicable, no hesitation need be felt in employing this substance.

Chloric ether is a pleasant substance, both in taste and smell, and in a very young or feeble person, I should feel disposed to employ it in preference to chloroform; but in ordinary cases, all other things being equal, inasmuch as a larger quantity of it is necessary than of either of the following, I should not think its use would be urged.

Hydrobromic ether is a safe, pleasant, and effectual anæsthetic, but inasmuch as it does not possess any such qualities as to render its employment more advantageous than some other substances, the very great cost of it will, unless this can be materially reduced, entirely prevent its general use. One manufacturer would not prepare it for me under one guinea an ounce.

Chloroform is undoubtedly one of the pleasantest and most powerful anæsthetic substances known; indeed, until I showed the safety of the chloride of olefiant gas, by far the most so. That it is the safest can by no means be maintained with equal certainty; on the contrary, in safety I believe it to be inferior to all the other substances mentioned just now. Some of the indications, for and against its use are alluded to under the heads "chloroform" and "ether," therefore need not here be repeated. There is, however, one unpleasant effect which sometimes follows the administration of chloroform that I have not seen noticed, but of which I have found more than one person complain, namely, that for long (even months,) after its inhalation, they have occasionally experienced the same sensations as they did at the moment of breathing it. A highly respectable professional man (solicitor,) has told me that he regrets having inhaled chloroform, which he did many months ago, at Cheltenham, in the extraction of a tooth; since then he has on three or four occasions suddenly awoke in the night, with precisely the same feelings that he had just before becoming unconscious while inhaling it. He is conscious, but unable to speak or to stir, and feels as though about

to die. After a time these sensations pass off, but leave him languid during the ensuing day. He never experienced anything of the kind before, and attributes them entirely to the chloroform. I have heard others say they regret having taken it, feeling nervous and more tremulous than before.

Chloride of olefiant gas.—This fluid I have now administered so frequently in practice, that I think I am justified in stating the inferences drawn from the experiments upon animals are correct. It appears to be unattended with the troublesome excitement produced by ether, on the one hand, and on the other with less of the tendency to collapse, which is so objectionable in chloroform; hence if that only true test, experience in general use, should confirm this opinion, it will form a not unimportant addition to the list of anæsthetic agents. In the report upon the action of Dutch liquid, which I made in the *Journal* of the Association, I was misled as to the relative cost of it and chloroform, in consequence of the price of the Dutch liquid sent to me by Messrs. Gale and Co. being much less than the price of chloroform when it was first used. I have recently had reason to think that owing to a want of care, ignorance, or some other cause, an improper method of manufacturing the fluid was employed, and that it contained spirit of wine; hence the lower cost of its production.

I would, however, here state that it appears not improbable that a combination of the chloride of olefiant gas with spirit, not a mere admixture of the two fluids, but a combination during manufacture, may probably prove, not only a sufficiently cheap, but a valuable anæsthetic; for, since the detection just mentioned, I have made several experiments upon dogs and cats with a mixture of pure Dutch liquid (made by Mr. Morson and Mr. Bullock,) and alcohol, and also of spirits of wine, in various proportions, the results of which I find to correspond with the effects stated to have been produced by that fluid which I now consider to be a combination of the two.

Chloride of Carbon.—As stated in note, p. 341, it being not improbable the fluid sent to me by the same parties as above-mentioned, is a chloride of a hydrocarbon, dissolved in spirit, I would not wish the experiments with it to be considered as final and conclusive; should, however, experiments with a pure chloride

of carbon confirm the supposition of its anæsthetic powers, and it be pleasant and safe in use, it will be generally employed, inasmuch, as I am informed, that it will shortly be prepared on a large scale, at a very small cost per pound.

QUESTION IV.—*Is there any essential difference in the action of these substances, according to the mode in which they are administered? Do they produce the same effects in whatever way they are carried into the body, or does the effect depend upon the nature of the tissue upon which they are applied? And does the same dose, when applied to the same tissue and in the same manner, invariably produce the same uniform results?*

This question, especially the first clause of it, has been already so fully discussed in the remarks upon the effects produced by the internal administration of these substances, and in the reply to the second question, that but little need now be said. Certainly the same dose, when taken into the stomach, does not (with one exception, hydrocyanic acid,) produce the same effect as when inhaled. Though whether this difference depends upon any dissimilarity in the nature of the two mucous tissues is by no means so certain, I am inclined to think not, but much rather upon the greater extent of surface which is brought into contact with the agents when inhaled, and their being in vapour.

With regard to the second part of the question, as to the uniformity of result, it may without hesitation be said that the same dose does not by any means always produce the same result. There is considerable variation in different individuals as to their susceptibility to the influence of these agents, one person or animal being far more easily affected than another. The *very* young (new-born,) animal will bear, not only a proportionably, but positively a larger quantity than the adult, as see Nos. 18, 19, 49, 71, 233, and others; while an older, but not an adult animal, will not bear the quantity which an old one of the same species will, as compare Nos. 1 with 4, 104 with 108. Moreover, at different times the same animal is far more susceptible to the influence of them than at another, as a comparison of No. 11 with No. 12, and No. 13 with 14, No. 16 with 17, and others which might be referred, will at once show.

Hysterical females are, and experiment 283 would show lively excitable animals also, much more susceptible to the action of these agents than the unexcitable and phlegmatic are. In one instance a lady called upon me while suffering from a paroxysm of tic doloreux, anxious to have immediate relief. I rubbed upon the face not more than twenty minims of chloroform with success; but while doing so, another lady who had accompanied her, and stood near, complained of feeling the effect of it. On leaving my house, instead of proceeding to some shops, as intended, the head of the second lady became so confused and giddy, that she was obliged to make the best of her way home again; indeed, she walked so unsteadily, that she afterwards told me she was quite afraid of being supposed to be drunk. She laid down, and slept for several hours afterwards. This lady is one of a family of the most highly hysterical diathesis I ever met with.

The quantity of any anæsthetic which is inhaled in a given time is of the utmost importance, *cæteris paribus*, the more concentrated the vapour by far the greater is the danger. Given slowly, the same animal will inhale at least twice the quantity without dangerous symptoms, that if inhaled very rapidly, would be not unlikely to cause death, as a reference to several of the preceding experiments will show.

QUESTION V.—*Are there any symptoms by which we may accurately judge of their effects, and ascertain and control the point to which the system may, with safety, be brought under their influence?*

This is a most important practical question. Though, without doubt, in every single case we cannot control the effect, yet, as a general rule, it may be affirmed that we can both judge of the effects and control the point at which we wish to arrest the influence of these agents, provided due care be used in administering them. It does occasionally happen that an animal, as No. 283 will show, (and I have not any doubt the same occurs in man,) is so susceptible to the action of chloroform and other substances, as to be so suddenly and completely brought under the influence of them, even a very small quantity being used, that

it may be found to be impossible to control their action or to prevent a fatal result.

To insure safety, the two principal points to be attended to in the administration of an anæsthetic, are the quantity of the substance used at once, and the temperature at which it is given. Of course, the higher the temperature the greater the quantity of vapour generated in a given time. It is of the utmost importance to take care that the vapour is not so concentrated as to produce a very sudden impression, or the nervous energy may be so suddenly and completely suspended that the heart at once ceases to act. I would here remark, that I think it is a very common fault to carry the anæsthesia too far. In order that no sensation of pain should be perceived, it is not necessary to render the patient so utterly powerless as to be altogether unable to stir, as I have often seen done, and as the inexperienced administrator is very apt to do. This is a point of especial importance in the practice of midwifery. I do not here enter upon the question as to the propriety or impropriety of giving chloroform, or any other agent, to the parturient woman, which would lead to a digression not included within the intention of this Essay; but I would remark, that if it be determined to use an anæsthetic agent, that one should be selected which gives rise to the least depression, either temporary or permanent, and that in all cases especial care should be taken to give as little as possible. It is rarely, indeed, necessary to produce unconsciousness, which is rather prejudicial than not, by suspending the pains and retarding labour; a dreamy condition of half-conscious obliviousness is, unless there be some considerable manual interference required, all that it is either necessary or desirable to produce. The plunging the woman into a profound state of unconsciousness has, I am convinced, often been productive of the worst and most fatal consequences.

The more simple the apparatus used in inhalation the better; and none, I think, taking all things into consideration, answers so well as a large, moderately, fine linen handkerchief, folded first into quarter size, and then into a funnel shape. It is far better than a thick towel; for, while it retains quite sufficient of the fluid, it does not obstruct the free ingress and egress of air so much, consequently the process of respiration is less disturbed. This I have sometimes seen so obstructed by the manner in

which a thick towel has been held over the nose and mouth, as to make me afraid of asphyxia being occasioned, and the patient being regularly Burked.*

The first indication of an animal being pretty well under the influence of the agent is the deeper, fuller, and more prolonged respiration; he inhales as though it were pleasant to do so. This is not always observed, though it very frequently is. At first there is some little excitement, and a disposition to move; the pulse is rather fuller and quicker,† the pupils somewhat contracted, and the eyes wandering; there is often incoherent talking; these symptoms speedily pass off, and loss of volition and indisposition, or inability to move, comes on; the eyes become upturned, the pupils dilated, the pulse smaller, the muscles flaccid, and unconsciousness and insensibility ensue. If the quantity of vapour be now lessened, the respiration becomes more free and natural; if not it will be laborious, and presently almost, or entirely cease. The lips become closed, and in expiration the cheeks may be distended by the air, which in escaping may produce a blowing

* A very thin, fine sponge, grown in the form of a depressed disk, sufficiently large to cover the nose and mouth, answers the purpose well; indeed, with dogs I found it more convenient than anything else. In the account of the interesting and valuable experiments made by Dr. Snow, and which he has been polite enough to send to me, since the first sheets of this paper were printed, I find he decidedly prefers a jar with a face-piece, as an inhaler, to the simple cloth, thinking the quantity of vapour can be more accurately measured and regulated. If this were so, there can be no doubt of its advantage. This, however, I do not think in practice is really the case, though it may be in theory. Whatever careful measurement may be contrived, much will depend upon the manner in which the patient respires, and the quantity of vapour supplied must be in a great degree at the discretion of the person having the charge of administering it. He must watch the effects carefully, and allow it to be more or less concentrated, according to these. This, I think, is quite as accurately and more easily regulated by the nearness or distance, the close envelopment or openness of the cloth, as it is by the opening or shutting of a valve. Besides, the great convenience of the cloth in every position of the body. Whoever has charge of the giving the vapour should be experienced in so doing, and should not have anything else to attend to. This is quite sufficient for one to watch; for though general rules and directions may be advantageously given, the application of them in the individual case must be at the discretion of the party who is entrusted with the duty.

† In some cases of lingering exhausting labour, where the pulse was small and quick, I have seen, immediately the chloride of olefiant gas was inhaled, the pulse in a surprising manner to rise in volume and to lessen in frequency. The same occurs with chloroform, but not, so far as I have witnessed, to the same extent.

noise. This I regard as a certain sign that the system is so fully under the influence of the anæsthetic, as to border upon danger. The distention and blowing noise arise, I think, from the total loss of motion and sensation in the lips and cheeks, which thus become mechanically distended by the force of the expired column of air. At this point, or before, (for the last symptom is by no means invariably present, the mouth being open instead of closed,) the pupils are widely dilated, the limbs become as flaccid as possible; there is no reflex action, the urine or fæces, or both, may involuntarily escape, the conjunctiva and lining membrane of the mouth often, indeed, the whole countenance, become pale and bloodless; the heart may be perceived acting most rapidly, with a short, feeble throb, the pulsation in the arteries being scarcely, if at all, perceptible, and the respiration becomes either very quick and inefficient, or slow and gasping. If this entirely stops for any length of time, even though the heart may be felt still to move, recovery will be very doubtful. In operating, if the surgeon should find the flow of blood to cease, he ought *immediately* to be on his guard, as this may indicate such a condition of anæsthesia as to seriously compromise the heart's action; and if the inhalation be carried farther, might be fatal.*

The indications, then, to be attended to in administering anæsthetics, especially the more potent, are:—

Not to employ too much of the agent at one time.

To take care that the temperature be not too high.

To be sure that the air can easily and freely pass into and out of the lungs.

Not in the first instance to allow the vapour in too concentrated a condition to be inhaled, which is easily regulated by not putting the cloth too closely over the face in the first instance; or, if an apparatus is used, to open the air valve. If there be no excitement, not to increase the strength of the vapour; but if there be excitement, then by applying the cloth more closely, or by shutting the valve, to terminate this by more fully and quickly

* Since this was written, the importance of the direction has been painfully shown in a fatal case reported in the *Lancet* for February 25th, 1849, where chloroform was given, without due attention to the cautions above pointed out, to a patient who underwent a small operation. Here the blood ceased to flow before respiration stopped.

bringing the system under the full influence of the agent, but taking care that so soon as there are indications of unconsciousness and insensibility being produced, in a great degree to withdraw the anæsthetic, and only to give such a diluted vapour as shall just suffice to keep up the condition of insensibility, which, when once produced, may be usually maintained by a very moderate quantity of vapour; for it must be borne in mind that the *full effect* is not always *instantly* produced as the vapour enters the lungs, nor do the effects always immediately pass off; indeed, the rapidity with which the effects disappear does not always correspond with their intensity. If these directions be attended to, rarely will death be occasioned by either ether, chloride of olefiant gas, or chloroform, although, as I have before stated, chloroform I consider to be the most dangerous of all; yet even of this, when due care is exercised, experience has shown the danger not to be very great.

I should not omit to mention that it is of considerable importance that the stomach should not be distended with food; if it be, vomiting is much more likely to be caused, and I think a fatal result is more easily induced in such a condition; at least in several of the animals in which a small dose destroyed life, the stomach was found distended with food recently taken, as in Nos. 4, 283, 292, and others. I have seen patients during, or immediately after, an operation under the influence of chloroform, vomit food recently taken, in which cases there was considerable depression for some period.

QUESTION VI.—*In case of an overdose, are there any means which can be employed to counteract the effects? Do we possess any antidotes, or are there any remedies? If so, what are they? In what manner do they act, and how should they be employed?*

This question has been in so great a measure answered in the remarks upon the effects of each of the means used as a remedy, that it would only be useless repetition to go over the same ground again. From what has been said, it will be seen that I consider safety is much rather to be found in the avoidance of an overdose than in seeking for an antidote or remedy against the effects of it. If an antidote of much value exists it has yet to be discovered.

Of the remedies mentioned, no one appears to possess any great power in such a condition of things as would call for its employment. It is true, agitation, cold affusion, a cold stream of air, perhaps electricity or galvanism, and some other stimulants, will expedite the process of rallying where the depression is not very profound; so, also, it is possible that venesection, by lessening the pressure of the column of blood upon the walls of the heart, especially the right, may, when this organ is still acting, facilitate its contraction, and thus assist in restoring the circulation; at the same time, it is by no means certain that, with such a depression as exists in the nervous energy, the abstraction of blood may not in itself tend to increase or, at any rate, to prolong this condition, precisely as it would do in syncope, to which state it appears not improbable that, induced by anæsthetics, bears some considerable analogy; an idea which the symptoms apparently brought on in the cat that had been in the light carburetted hydrogen, No. 167, by holding her in the upright position, would strengthen; and, if correct, would point out the horizontal as the proper position for a person in such a state to be placed in.

But we have seen in the great majority of cases, so long as the heart acts and respiration at all goes on, the mere withdrawal of the anæsthetic is followed by the restoration of the functions, and therefore the question forces itself upon us as to the positive value or not of any of these means. If the heart has ceased to act no blood will flow on a vein being opened. If respiration has ceased, and the heart does not move, galvanism, as the experiments 291, 292, and 293 show, though it may make the voluntary muscles violently contract, only does this by the sooner exhausting their power to do so, without in any way restoring the vital functions. Oxygen, of course, if there be no respiration, cannot be taken into the lungs, and the performance of artificial respiration with it would be both difficult and incomplete, even were it at hand, which it would not in the great majority of cases be, while, so far as experiment and chemical action goes, it does not appear that if it were ever so fully inhaled, even in combination with the anæsthetic substance, it would in any manner prevent the development of full anæsthesia, and therefore it cannot be for a moment imagined it would in any way counteract the effects when they are developed. Ammonia we have seen to be useless and inert, whether given mixed with the

substance or after its effects were produced. The coldness and depression which in so marked a degree are present do not encourage us in the supposition that either cold water or cold air, to any very great extent, would be useful—a conclusion which the experience of their effects confirms. We are, therefore, reduced to seek just that assistance from their use as shall suffice to produce such a moderate shock, if the nervous system be capable of receiving any, as may cause a reaction and rousing of its powers, by which the heart and respiration may again be set in motion, or rendered more vigorous. This, as I have before said, appears far more likely to be accomplished by the sudden dashing of a small quantity of cold water upon the face and chest, possibly alternating with heat to the latter, or such a moderate stream of air as may be produced by a fan, and a not too violent agitation of the body, than by excessive violence or by entire and long-continued immersion. A moderate interrupted compression of the chest, and pressure upwards of the abdominal viscera, should not be neglected, as tending to change the air in the lungs, and thus to get rid of the vapour there remaining; or, with the same intention, a stream of air might be, not too forcibly, blown through a small tube into the larynx for a minute or two.

These are remedial means which some will, I doubt not, be disposed to exclaim are very paltry and meagre, and which, it must be allowed, are not of a very energetic or hopeful character; but it is far better to employ such as may do a little good than to have recourse to those which not only may, but probably will, do a great harm; and, further, it is far better to know to what extent our knowledge and power do extend, even if it be to make us aware that this is not only very limited, but absolutely amounts to nothing, than to shut our eyes and cloak ourselves with ignorance and meddlesome presumption, lest our inability should be revealed. This error can only be attended with absolute and unmitigated evil; the other course, if it does not, as it probably will, lead to future good, will at any rate prevent us from doing harm. It will teach us that which is the hardest and last lesson medical men learn, and which, when learnt, in consequence of the ignorance of those with whom we have to do, requires no little moral courage to carry out—of when not, as well as when, to interfere—a lesson which, however,

perhaps all the world, learned and unlearned, in common with ourselves, is slow to learn—belief in, and reliance upon, some means or things upon almost every occasion, and under almost every circumstance, apparently being inherent in human nature. It is, however, a lesson which was never less understood than at the present day, when we see a perfect scepticism in rational means, founded upon the clearest evidences of induction and experience; because, in their ignorance, persons have expected more than nature would allow to be performed; most absurdly combined with the weakest credulity in the power and efficacy in certain manipulatory processes upon infinitismal atoms of inert matter, which, did not one's better nature feel indignant at the mischief occasioned by the officiousness of the believing, weak, and vain, and the criminal knavery of the cunning, who, to comply with this belief, pretends to use active means, while he knows that he is not doing anything, would raise a smile at the incongruous and ludicrous exhibition of the human mind.

MEMOIR

ON THE

MEDICINAL ACTION OF ARSENIC;

COLLECTED FROM THE

REPORTED EXPERIENCE OF THE MEMBERS OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION,

AND OTHER SOURCES.

BY THOMAS HUNT, M.R.C.S., &c.

The following Memoir may be regarded as the first fruits of a *plan for the advancement of medical science,* submitted to the Members of the South Eastern Branch of the "Provincial Medical and Surgical Association," at their annual meeting, held at Ashford, June 24, 1846. It consists chiefly of an arranged abstract of the replies of the Members of the Association, and other practitioners, to a series of questions addressed to the former through the medium of the *Provincial Medical and Surgical Journal,* and to the latter, by private communication. The number of replies received from the Members amounts to twenty-nine; the contributions received from other sources are forty-six in number, consisting chiefly of the replies of the author's own professional friends, to whom, as well as to the respondent Members of the Association, he takes this opportunity of returning his most cordial thanks. Some of these contributions are, as will be seen, extremely valuable; and it would be highly gratifying, if it would not appear invidious, to signalize the names of the authors whose letters are most highly esteemed. All that can be done, however, with propriety, by way of personal acknowledgment, is to subjoin a list of all the Members who have contributed, which list I am proud to exhibit, as containing many names dear to the cause of medical science. In addition to this, I may be allowed to express my especial obligations to Dr. James Heygate, then President of the Association.

and to Dr. Charles Hastings, President of the Council, not only for their official sanction to the prosecution of the plan, but to their prompt replies to the questions. To the medical officers of the provincial hospitals, infirmaries, and dispensaries, who have related their experience, special thanks are likewise due, not only on account of the superior opportunities of observation which their position affords them, but for the sacrifice of time, (the value of which their public engagements must enhance,) to the purposes of this inquiry. The kind assistance and encouragement afforded me by our late much lamented secretary and editor, Dr. Streeten, it would be ungrateful to pass over in silence. Nor can I forget the prompt and zealous aid of Mr. Martin, of Reigate, the much respected Secretary of the South Eastern Branch, who kindly forwarded my views, and commended the design to the notice of the Members of that division of the Association.

It will be a matter of surprise to some, and of regret to all, that the number of respondents bears so small a proportion to the whole number of Members. But it would be unjust to charge the non-respondents, or any one of them, with indifference to the progress of medical science. The more rational, as well as more liberal, construction to be put upon the silence of the majority, is that arsenic is so little used in the profession, that many practitioners have no return to make,—a conclusion which, by way of corollary, invests the inquiry with additional importance, inasmuch as it appears (as will be seen in the sequel) that arsenic does not really merit the neglect or reprobation of the profession. The delay which has occurred in the compilation will be readily excused by those of our brethren who are much engaged in practice, and it is even now prematurely published. It was my intention, as proposed in the first instance, to compare the results of this inquiry with existing authentic records, spread over the surface of periodicals and treatises. I found, however, that had my time and opportunity allowed me to attempt such an undertaking, the Essay would have been necessarily expanded to a bulk too voluminous for the publications of the Association. I shall, however, cherish a hope of accomplishing the task on a future day, and of laying the results before the profession in some form.

The following gentlemen have replied, more or less promptly, to the printed queries addressed to them; and to them the profession is indebted for whatever is practically valuable in this Memoir:—

RESPONDENT MEMBERS OF THE ASSOCIATION.

Amyott, T. E., Esq., Surgeon, Diss, Norfolk.
Arrowsmith, J. Y., Esq., Surgeon, Shrewsbury.
Bainbridge, F., Esq., Surgeon, Harrowgate.
Barham, Charles, M.D., Truro.
Brown, T., Esq., Surgeon, Castle Donnington.
Cooper, Henry, M.D., Hull.
Cowan, Charles, M.D., Reading.
Crompton, Samuel, Esq., Surgeon, Manchester.
Dix, William, M.D., Long Buckby.
Evans, Evan, Esq., Surgeon, Leeds.
Forbes, John, M.D., F.R.S., &c., Old Burlington Street, London.
Fox, Joseph, Esq., Surgeon, Falmouth.
Graveley, Richard, Esq., Surgeon, Rigmer, Lewes.
Hamilton, John, Esq., Surgeon, Elland.
Hastings, Charles, M.D., F.G.S., Worcester.
Heygate, James, M.D., F.R.S., Derby.
Jackson, Matthew, Esq., Surgeon, Market Weighton.
King, D. H., Esq., Surgeon, Stratton.
Mackness, James, M.D., Hastings.
Newnham, W., Esq., Surgeon, Farnham.
Payne, Henry, M.D., Nottingham.
Pope, Thomas, Esq., Surgeon, Cleobury Mortimer.
Probart, Frank George, M.D., Bury St. Edmunds.
Rudge, Henry, M.D., Leominster.
Salter, T., Esq., Surgeon, F.L.S., Poole.
Smith, T. H., Esq., Surgeon, Crowley.
Smith, T. H., Esq., Surgeon, St. Mary Cray.
Sweeting, W., Esq., Surgeon, Abbotsbury.
Webster, George, M.D., Dulwich.

RESPONDENT NON-MEMBERS.

Ancell, Henry, Esq., Surgeon, Norfolk Crescent.
Andrews, Thomas, Esq., Surgeon, Canterbury.
Bateman, Henry, Esq., Surgeon, Islington Green.
Bennet, J. H., M.D., Cambridge Square.
Bird, Golding, M.D., Myddelton Square.
Brodie, Sir B. C., Savile Row.
Brown, I. B., Esq., Surgeon, Oxford Square.
Bull, Thomas, M.D., Finsbury Square.
Cassells, R., M.D., Manchester.
Collambell, Charles, Esq., Surgeon, Lambeth.
Cooper, T. S., Esq., Surgeon, Canterbury.
Crawford, Mervyn, M.D., Upper Berkeley Street.
Elliotson, John, M.D., Conduit Street.
Erichson, J. E., Esq., Surgeon, Welbeck Street.
Gasquet, R., Esq., Surgeon, Euston Place.
Girdwood, G. F., Esq., Surgeon, Southwick Crescent.

Greaves, George, Esq., Surgeon, Hulme, Manchester.
Green, Joseph Henry, Esq., Surgeon, Hadley.
Hunter, John, Esq., Surgeon, Great Tower Street.
Hurd, James, Esq., Surgeon, Frome.
Iliff, W. T., Esq., Surgeon, Newington.
Jones, F. C., M.D., Blackfriars Road.
Key, C. A., Esq., Surgeon, St. Helen's Place.
Linnecar, E. H., Esq., Surgeon, New Basinghall Street.
Lochee, A., M.D., Canterbury.
Lyon, E., M.D., Manchester.
Mc Whinnie, A. W., M.D., New Bridge Street, Blackfriars.
Major, D.B., Esq., Surgeon, Canterbury.
Mantell, Gideon, Esq., Surgeon, Chester Square.
Parrott, J., Esq., Surgeon, Clapham Common.
Paxton, James, M.D., Rugby.
Pilcher, George, Esq., Surgeon, Great George Street.
Randall, Alfred, Esq., Surgeon, Finsbury Square.
Ray, Charles, Esq., Surgeon, Gracechurch Street.
Roupell, G. L., M.D., Welbeck Street.
Saner, James, Esq., Surgeon, Finsbury Square.
Scudamore, Edward, M.D., Canterbury.
Spurgin, John, M.D., Guilford Street.
Thompson, A. T., M.D., Welbeck Street.
Thompson, Theophilus, M.D., Bedford Square.
Ure, Alexander, Esq., Surgeon, Bloomsbury Square.
Wakefield, H., Esq., Surgeon, Lansdowne Place.
Walshe, W. H., M.D., Queen Anne Street, Cavendish Square.
Waterworth, C., Esq., Surgeon, New Kent Road.
Wetherfield, J., Esq., Surgeon, Henrietta Street, Covent Garden.
Wilson, Erasmus, Esq., Surgeon, Upper Charles Street.*

* To the above list of correspondents I have the pleasure to add the name of James Startin, Esq., the surgeon to, and founder of, the London Cutaneous Institution, to whom I am indebted for replies to the queries, as well as an explanatory note. The substance of Mr. Startin's replies I have *not* embodied in the Report, for reasons which I trust will be satisfactory to the Members, as well as to himself. They are as follows:—1. Mr. Startin reports that he has had the opportunity of watching the internal administration of arsenic, "certainly in not less than *twenty thousand cases*." 2. He states that he seldom or never gives the mineral *uncombined*. Now, as the aggregate number of cases reported by other gentlemen, (who *have*, for the most part, given it *uncombined*,) can scarcely be estimated at one-fourth of this number, it is evident, that by including Mr. Startin's cases, we should have so overwhelming a preponderance of cases in which the medicine was administered *in combination with other medicines*, as to deprive the Report of its real value as a statistical document. 3. Mr. Startin professes his intention to place many of his facts before the profession: it would, therefore, be scarcely fair to anticipate his intention, by giving an imperfect and hasty report. I may, however, be permitted to state, that his experience in the use of arsenic, as a therapeutic agent, coincides very generally with that of other correspondents, with one marked exception, viz.,—that he does *not* regard it "as the panacea for cutaneous diseases it is believed to be by some writers." It will be observed, in the perusal of this memoir, that a large majority of the reporters are accustomed to regard arsenic, if not as a panacea, still as a very useful and efficient medicine in cutaneous diseases. Mr. Startin's experience most certainly entitles him to speak with confidence on this point; and it appears to be at variance with that of his professional brethren, who will look with anxiety for his report, which, it is to be hoped, will state fully all the circumstances which may in any way account for the discrepancy.

ON THE MEDICINAL ACTION OF ARSENIC.

In endeavouring to analyse the mass of information placed in my hands by the kindness and zeal of my brethren, I find a large number of valuable *facts* more or less mixed up, in many instances, with *opinions*. Many of these opinions proceed from sources which entitle them to the highest respect of the profession, *as* opinions, and some of them it would be unpardonable to bury in oblivion; but my first duty is to separate them entirely from the facts on which they are founded. This having been done, the facts lie before me in such a variety of forms, and supported by such different degrees of demonstration, that it has been an undertaking of no little difficulty to arrange them with rigid fidelity and care. I propose first to take the questions as they were originally printed in the *Provincial Medical and Surgical Journal*, and present a faithful *abstract* of the answers; and afterwards to arrange and digest them in such a form, as may show the practical conclusions to which they lead.

Question I.

"In how many cases have you had an opportunity of watching the internal administration of arsenic in medicinal doses?"

To this question the replies are definite from some gentlemen, and indefinite from others. The definite replies present an aggregate of 1,651 cases. The indefinite consist of such expressions as "many," "very many," "a great many," "a very great number," "a great many for fifty years," "frequently for thirty years," "hundreds," &c. &c. On the *lowest* calculation, allowing 200 for the term "hundreds," and 20 for the term "many," &c., this indefinite number must be set down as considerably upwards of 1,500, which, added to 1,651, makes upwards of 3,000 cases. Perhaps they might justly be put down at 5,000. But it will be quite safe to consider that the following memoir presents the results of 3,000 cases, in which arsenic has been used medicinally, by seventy-five different practitioners in various counties in England,

for the last half-century, about one-half of the number being metropolitan practitioners.

Question II.

"Did you ever see a case in which arsenic, so administered, (medicinally,) proved fatal?"

All the answers to this question are, without exception, "never;" and I am bound to add that the same reply is given by Mr. Startin, whose reported experience, for reasons already explained, is not embodied in this memoir.

Question III.

"Have you any proofs that, under your own observation, arsenic has ever, in medicinal doses, proved seriously or permanently detrimental to health? If so, state the symptoms, and mention the facts which prove that arsenic was the injurious agent."

The answers to this question will be conveniently arranged in two classes. First, as to the question of *permanent* detriment to the health, every reply is in the *negative*. Secondly, as to the question of *serious* injury of temporary duration, the replies are all in the negative, with the following five exceptions; in one of which, carditis followed its use; in a second, mania; in a third, dysentery; in a fourth, vomiting, perspirations, bloody urine, and vesicles on the feet; and in a fifth, colic. In no one of these cases is there absolute proof that arsenic was the real cause of the affection, although in two of them (the second and fourth,) the extremely large doses which were administered render it highly probable. But, that the reader may judge for himself, I will subjoin the particulars of each case.

Case 1.—(Related by Mr. Jackson, of Market Weighton, Yorkshire.)—"A lady, aged forty, of sanguine temperament, had for some months been labouring under a cutaneous affection of the upper extremity—in appearance resembling urticaria. She took of Donovan's Solution, five drops three times a day. On the fifth day carditis supervened. She did well, and the eruption was cured."

I take the liberty of making a few remarks on this case, and those which follow. Mr. Jackson's letter is fully entitled to every attention. His style evinces close observation, and a general conviction of the efficiency of arsenic in cutaneous diseases; and I may add that his experience generally harmonizes with my own. But perhaps he will agree with me, that this case presents no satisfactory proof of the action of arsenic on the heart, for two reasons:—First. The symptoms of carditis, (inflammation of the muscular structure of the heart,) a very rare affection, are equivocal, and dissection has not yet distinguished them; and Second, Donovan's Solution, containing mercury and iodine, as well as arsenic, may be, and doubtless is, a very efficient preparation, but its effects cannot fairly be attributed to the arsenic *alone*.

Case 2.—(Related by Mr. Fox, Surgeon to the Falmouth Dispensary.)—"The patient was an hysterical female, whose fits were sometimes of the *epileptic* character. A physician prescribed for her the liquor arsenicalis, in doses of *ten drops, gradually increased to twenty, to be taken four times a day.* The throat became inflamed; she complained of severe burning pain in the stomach and bowels; the conjunctivæ were also inflamed, and the whole body covered with an eruption of papulæ. These symptoms were relieved in a few days by a discontinuance of the arsenic, and proper medical treatment; but they were soon followed by an attack of *mania,* which lasted two or three weeks, and which has never returned. She is still subject to the fits, for which the arsenic had been prescribed."

This case is instructive, as it faithfully discloses the symptoms not unfrequently resulting from excessively large doses of the mineral, viz: inflammation of the mucous membranes, commencing in the conjunctiva, and descending to the nose, throat, stomach, and bowels, with a papular cutaneous eruption:—*all relieved in a few days* by discontinuing the medicine and proper treatment. *Afterwards* mania supervened. Now mania very frequently follows epilepsy, and occasionally hysteria. I know of no recorded case in which it followed arsenical medicines. *Ergo,* it is fair to consider it rather as a link in the chain of nervous affections to which the patient was a victim, than a consequence of the administration of arsenic (even in enormous doses,) for their cure.

Case 3. *Dysentery.*—(Related by Dr. J. H. Bennet, of Cam-

bridge Terrace, who gives no opinion of the case.)—"I once had, at the Hospital of St. Louis, Paris, a case of severe chronic dysentery of eighteen months duration, with pain in the limbs and joints, treated elsewhere (previously,) by arsenic, to which these symptoms were attributed."

Although I have thought it my duty to quote this case, it is clear that the facts are too much obscured to prove anything whatever.

Case 4.—(Related by Dr. Theophilus Thompson, of Bedford Square.)—"A gentleman to whom I had given Fowler's Solution for three months, persevered with eight minim doses, after stiffness of the eyelids and nausea had occurred. Violent vomitings followed; perspirations and copious discharge of urine, which appeared to contain blood. In this instance some vesicles appeared on the feet (an appearance which I have somewhere seen mentioned as an occasional effect of arsenic); the eczema, which had been relieved, was now again aggravated, but after a suspension of the remedy for a few weeks, *it was resumed with more vigilance and precaution, and with ultimate recovery.*"

These symptoms are so characteristic of an over-dose of arsenic, that no one can doubt their origin. The vesicles on the soles of the feet, I have recently noticed in three different cases.

Case 5.—(Also related by Dr. T. Thompson.)—"A lady, suffering from tic doloreux, took a quinine mixture, with the addition of four minims of liquor potassæ arsenitis to each dose. The *next day* she had an intense attack of colic, which lasted twenty-four hours, notwithstanding the use of large doses of opium. If this was the effect of arsenic, I suppose there was some peculiarity of constitution; for it is a solitary instance, in my experience, of so violent an effect from so small a quantity of the medicine." The proof would have consisted in a subsequent trial of the arsenic. In my work "On the Skin," I have related a case of prurigo, in an elderly lady, so exactly parallel with the above, that I am tempted to refer to it, (pp. 32, 33.) After taking two or three doses of arsenic, the patient was seized with severe colic and vomiting. "The arsenic was discontinued, and suitable remedies having been successfully administered, *it was resumed,* (three days afterwards,) and continued steadily for a fortnight, *without producing any sensible effect.*" I am the more disposed

to attribute the colic, in Dr. Thompson's case, to some other cause, because he very properly administered arsenic freely diluted, and on a full stomach; under which precautions, the stomach and bowels more rarely suffer from small doses.

The only conclusion which can be drawn from these cases is, that the administration of *excessive* doses of arsenic is liable to be attended with temporary inconvenience, the symptoms varying, both in kind and degree, with the mode of administration, and the constitution of the patient; but that these symptoms are neither dangerous nor liable to become permanent; for they uniformly subside upon the discontinuance of the medicine, which may afterwards be safely and beneficially resumed.*

It seems necessary to add, that the case of local paralysis following the use of arsenic, read by Dr. Hastings, at the last Anniversary Meeting of the Association, and printed in the *Provincial Medical and Surgical Journal*, (August 23, 1848, p. 459,) had not occurred when Dr. Hastings kindly responded to my enquiries in January, so that it is not included in my list. I may also here refer the reader to a case related by Dr. Barham, which will be found in his reply to Question 14. It presents, at all events, a fact of interest, under which title Dr. Barham very properly classes it; but whether the symptoms are to be referred to the *post hoc*, or the *propter hoc* category, may be considered as still doubtful. The original disease was curious, and the case was treated with too much circumspection to present any strong points of practical instruction.

Question IV.

"Did you ever see it (arsenic,) administered without producing any apparent effect on the system; and if so, in what doses, and how long was it persisted in?"

* In a letter addressed by me to Mr. Martin, the Secretary of the South Eastern Branch, and read at the Annual Meeting, at Tonbridge Wells, June 28th, 1849, I stated, "that out of the records of a multitude of cases, in no one instance did it appear that the medicinal exhibition of arsenic, not always cautiously administered, has proved either fatal or seriously detrimental to the health." At the Annual Meeting, held at Bath in the August following, a Dr. Tunstall, (who has not yet favoured me with his valuable experience in arsenic,) is represented to have denied both the *facts* and the *deductions*, because he should otherwise be "accessory to the death of thousands!" I should be sorry to lead the Doctor into an error; but I cannot alter the facts, whether he "deny" them or not. The "deductions" are quite at Dr. Tunstall's disposal, even if he should be *accessory to their death*.

From *twenty* respondents an answer is returned in *the negative.* From *fifteen* the answer *is affirmative;* and *four* of these gentlemen report, that such a thing has happened "frequently;" *another,* "in seven cases;" *two others,* "in a plurality of cases;" *one,* "in two cases;" and *the rest,* "in one case."

Ten drops of Fowler's Solution is reported by one gentleman to have been administered thrice a day, for three or four weeks, without any sensible effect.

Another correspondent has given it "frequently" in large doses, and continued for a long time, without any sign of its presence.

Another; five minims for several weeks.

Another; four minims to twenty, for two or three months.

Another; six minims every six or eight hours, continued for three or four weeks.

Another; in lepra, for many months.

One gentleman continued it for four months, in seven cases, without effect.

One; ten minims, three times a day, for two or three months.

In none of these cases was there any sensible effect produced. It is very evident that before any positive conclusion can be drawn from these facts, (which must be somewhat startling to those readers who have used the medicine but sparingly,) the question presents itself, was the medicine pure and of proper strength? As this inquiry is comprehended in Question XI., it will be discussed in its proper place.

Question V.

"In what disease or diseases have you seen arsenic useful, and to what extent? What proofs can you give of its efficiency?"

Two or three gentlemen only, out of the whole number of respondents, report that they have frequently been disappointed in arsenic. One of them says that he has "employed it *very, very* little, chiefly in eruptive diseases, but without success:" that he has tried it in two cases of psoriasis for a great length of time, until both doctor and patient were tired, without effecting much good. Another correspondent says, "Generally speaking, it has failed under my administration of it, in several of the disorders where its efficiency has been most strongly declared."

One of these gentlemen is the senior surgeon of a provincial hospital, and very largely engaged in private practice; the other is physician to one of the metropolitan hospitals, also in good practice; both men of observation and ample opportunities. They give no particulars of their cases, having no notes; nor can I in any way account for their disappointment in the use of a medicine in which almost every other correspondent, who has used it largely, speaks in the most confiding terms.

The diseases in which arsenic has proved eminently useful would appear, from the reports before us, far more numerous than either the compiler, or probably any one of the correspondents, would have imagined.

The following list specifies the diseases in which it has been used successfully. The numbers refer to the practitioners under whose observation it has been used in each disease:—thus, 63 report its use in cutaneous affections.*

Cutaneous affections	63	Scrofula	1
Neuralgia	32	Remittents	1
Intermittents and malarious disorders	31	Chronic head-aches	1
Uterine affections, including uterine hæmorrhages	8	Cachexia	1
Chorea	6	Profluvia of mucous membranes	1
Chronic rheumatism	4	Epilepsy	1
Syphilis (secondary)	3	Cases requiring tonics	1
Carcinoma	3	Anæmia	1
Dyspepsia	2	Hysteria	1
Hypochondriasis	1	Ulcerations of the leg	1
Lumbago	1	Cephalalgia	1
		Hemicrania	1

To this table I have only to add, at present, that arsenic appears to have been more *uniformly* successful in *intermittents* than in any other diseases. Such is clearly the testimony of the contributors.

Question VI.

"Irrespective of its therapeutical efficacy, what effects have you observed to result from the medicinal use of arsenic? And

* These are not reports of solitary cases, but of general professional experience in the different diseases enumerated. It is impossible to specify how many cases belong to each disease. The cutaneous affections mentioned consist of sixteen different varieties; but the majority are in favour of its special efficacy in *squamous* disorders.

what proof can you adduce that these effects were real, not imaginary?"

The latter part of this question has been so sparingly replied to, as to throw a shade of doubt over many of the responses to the first part. In other words, the effects attributed to the use of arsenic partake, in too many instances, more of the nature of opinions than of demonstrable facts. I shall adduce the facts which are supported by evidence, and reserve the opinions for future observations.

1. Mr. Bainbridge.—"Occasional head-ache and shivering." *Proof:* "It subsided, on discontinuing the arsenic."

2. Dr. M. Crawford has graphically described the effects of arsenic as consisting in "Some indescribable disorder of the nervous system, restlessness, broken sleep, and vague internal feelings of alarm." *Proof:* "The patient not knowing he was taking arsenic."

3. Mr. Evan Evans.—"Some irritation of the stomach." *Proof:* "Readily subsiding, on discontinuing the arsenic."

4. Mr. Iliff.—"Slight disturbance of the digestive organs." *Proof:* "Patient not aware he was taking arsenic."

5. Mr. Linnecar mentions "Itching of eyelids, nausea, and pain in the stomach and bowels." *Proof:* "Their cessation when the medicine was discontinued."

6. Mr. Smith, of Crawley, mentions "Muscular tremors." *Proof:* "Twice produced, and subsiding on omitting the arsenic."

Besides these, *fourteen* respondents mention "affections of the conjunctiva and eyelids;" *nine* answer "none;" *six*, "nausea;" *five*, "heat, or constriction of the œsophagus;" *four*, "vomiting," "headache," "purging," and "gastrodynia;" and *one* or *two* only mention other symptoms not less than twenty-five in number, which (though there is no proof given that they really resulted from the medicine,) may be deemed worthy of being recorded. They are as follows:—Cutaneous eruptions, (hespetic, papular, vesicular,) itching of the skin, debility,* pain in the bowels,

* That some practitioners should mention "debility;" and "diminished strength," and others "an invigorating effect," as *invariable* effects of arsenic, appears contradictory; but the truth is, its primary effect is almost always tonic and invigorating; its secondary effect, occasionally depressing.

swimmings, giddiness, shivering, ptyalism, increased appetite, œdema, anorexia, thirst, feverishness, white tongue, heat of abdomen, tonic effect, alterative effect, swelling of the limbs, swelling of the knees. Both of the two latter symptoms are described as resulting from "too large doses."

Question VII.

"Is there any one symptom (or more,) which you have found invariably resulting from the exhibition of arsenic; and what symptom or symptoms?"

To this question, *twenty-three* replies are in the "negative;" *seven*, "conjunctivitis," or "tumid eyelids;" *two*, "nausea," or sickness;" and the following symptoms are severally mentioned, each by *one* respondent only, viz: "burning pain in the stomach," "an invigorating effect," "heat and constriction of the œsophagus," "emaciation," "diminished strength, *if long continued*," "gastrodynia," "universal warmth," "swelling of the face," "pityriasis," "swelling of the limbs, if pushed too far," "slight purgative effect."

Question VIII.

"Have you noticed much variableness in its action in different cases, or the contrary? Have you observed its effects modified by age, sex, or idiosyncracy; and to what extent?"

Nine respondents reply in the affirmative, and *seventeen* in the negative; and *one* observes that females seem more susceptible of its irritating tendency than males.

Question IX.

"State generally the conditions which have guided you in the administration of arsenic; what you have observed as the signs of an overdose; and what the circumstances which, in your experience, have seemed to contra-indicate its use?"

This question, it will be observed, has relation, not to any absolute facts regarding the operation of arsenic, but it was intended to elicit a general record of the *opinions* held by the

profession, and the general *practice* founded upon these opinions. The answers are therefore to be considered, not as scientific, but as historic facts. They present a record, as far as it can be obtained, of the opinions of the British members of the profession, on the medicinal action of arsenic on the human system, in the middle of the nineteenth century. The history is, of course, very incomplete, but it is faithful and true as far as it goes, and may be read with interest as well in future ages as at the present time. The replies are extremely various, but not so contradictory as to show a very important discrepancy of opinion. Indeed the variations of opinion may be fully explained by the variableness of effects observable by individuals in the action of the medicine, as well as by the distinction between its *primary* and *secondary* action.

1. The conditions which have guided the several respondents; or, in other words, what they have conceived to be the indications for its exhibition, are comprised in the following terms, viz:—

The phlegmatic rather than the sanguine temperament.
Cachectic lax-fibred habits.
When other medicines fail.
In periodic diseases.
Debility.
Atonic state of the system.
Good general health.
Obstinacy of the disease.
The presence of lepra.
The chronic character of the disease.
General pallor.
Slow circulation.
General coldness.
Non-inflammatory condition.
Freedom from febrile or mucous irritation.

2. The following are mentioned by the various contributors as the signs of an over-dose, viz:—

Irritation of the mucous membranes.
Headache, with flushings.
Sickness and pain in the stomach.
Sickness or purging.
Gastric symptoms.
Unusual violence of the usual signs.
Restless nights.
Desquamation of the cuticle.
Swelling of the features.
General inflammatory state.
Tympanitis.
None.
Conjunctivitis.
Intermittent pulse.
Nausea.
Pain in the stomach.
Exhaustion.
Sinking.
Palpitations.
Giddiness.

3. The following circumstances have been considered, by the several respondents, as contra-indicating the use of arsenic, viz:—

Unsound lungs.
Natural irritability of mucous membranes.
Plethoric and inflammatory states.
Tonic condition of the system.
Sanguineous temperament.
Inflammatory tendency.
Tendency to sudden nervous exhaustion, from any cause.
Irritability of constitution.
Acute diseases.
Proneness to irritability of the circulative or assimilative system.
Eczema mercuriale.
Head symptoms.
Organic disease.

Question X.

"State particularly what preparations you have used; what doses; whether administered on a full stomach or fasting; whether in increasing, decreasing, or uniform doses; whether alone or in combination; whether in hospital or private practice?"

The replies to these particulars tend to throw some light over the general results, and we have especially to thank the correspondents for the minuteness of many of their responses on these points.

1. The preparation generally used appears to have been the liquor potassæ arsenitis of the Pharmacopœia. About *fifty* gentlemen specify this; *four* mention the arsenious acid; *four*, Donovan's Solution; *one*, the arsenite of ammonia; and *one*, the iodide, ioduret, and deuto-ioduret of arsenic. Five-sixths, therefore, appear to have used Fowler's Solution exclusively.

2. This preparation has been used in a great variety of doses, varying from one minim to twenty, three times a day, or oftener. The following particulars are arranged from the practice of the different respondents:—

Min. x. to xx. ter in die.
—— x. to xv. ter in die.
—— x.
—— vi.
—— v. to x. quarta quaqua hora.
—— v. ter in die.
—— iv. ad. xii. ter in die.
—— v. ad. xx. "in intermittents."
—— v. ad. x. ter in die.
—— iv. ad. xiv. ter in die.

Min. iij. ad. xv.
—— iij. ad. viij. sexta quaqua hora.
—— iij. ad. x.
—— iij. ad. iv. ter in die.
—— iij. ad. v.
—— iij. ad. xv.
—— ij. ad. vi.
—— ij. ter in die.
—— i. ad. v. ter in die.

Donovan's Solution ... ... min. x. ad. xxx. ter in die.
Ditto ... ... min. v.
Iodide ... ... gr. $\frac{1}{10}$ ad. gr. $\frac{1}{4}$ bis in die.
Arsenious Acid ... ... gr. $\frac{1}{20}$ ad. gr. $\frac{1}{6}$.
Ditto ... ... gr. $\frac{1}{12}$ ad. gr. $\frac{1}{4}$.

The doses of the other preparations are not specified.

3. *Nineteen* practitioners are accustomed to administer the medicine on a full stomach; *nine* give it fasting.

4. *Twenty-one* respondents report that they have been in the habit of administering arsenic in *increasing* doses; *thirteen*, in *uniform* doses; and *five*, in *decreasing* doses. Of these five, however, two have given it frequently in increasing doses, and two in uniform doses. The results, therefore, of the practice herein recorded, may be looked upon as the effects of arsenical treatment, conducted on the principle of beginning with a small dose, and gradually increasing it till its effects become apparent. I have elsewhere explained that this is a most infelicitous and disadvantageous mode of administering a medicine, the effects of which are marked by a *cumulative* action on the system. My own published experience has shown that arsenic will accomplish infinitely more on the plan of reducing the dose, (commencing with a full or moderate dose,) than by the opposite method. Indeed, its maximum efficiency in chronic disease must always depend upon its prolonged and continuous use. What, then, may not arsenic accomplish, if our brethren will only be persuaded to adopt this obviously preferably plan? Uniform doses are indeed desirable so long as no sign is shown, but no longer.

5. *Twenty-six* practitioners have administered it "alone;" *two*, "combined;" *three*, "with a few drops of laudanum;" *one*, with "quinine;" and others have given it occasionally combined with decoction of dulcamara, with common salines, with valerian, quassia, liquor potassæ, cinchona, elm bark, sarsaparilla, mercury, antimony, paregoric, bitters, and aromatics.

6. *Fifteen* have used it in private practice alone; *two*, in hospital practice alone; and *nine*, in both public and private practice.

Question XI.

"What proof can you offer that the preparation you have used was pure?"

Eleven correspondents reply that they have obtained it from a "respectable house;" *four* from "Apothecaries' Hall;" *eight* deduce its purity from its "good effects;" *six* "prepared it themselves;" *one* "tested it;" and *five* adduce no proofs at all.

Question XII.

"Have you ever used arsenic externally? In how many cases, in what diseases, and with what effect local and constitutional?"

It appears to have been used externally *with advantage* in cancer, by *four* practitioners; in fungous sores, by *two;* in lupus, by *two;* in fistulæ, white swellings, and ulcers on the toes, each by *one* practitioner: *with no advantage* in cancer by *one* gentleman. *Four* other correspondents have used it in lupus and cancer, but do not specify with what effect.

One or two speak of its effects externally used, as similar, with regard to the constitution, to its effects internally exhibited. It appears to act by absorption, and if its effects could be *regulated,* the primary effects on the stomach and bowels might be prevented by this method of administration.

Of all the respondents, only *fourteen* appear to have used it externally; and of these, *one* has found it act as a caustic, rapidly, deeply, and efficiently, without constitutional disturbance; *another* has used the deuto-ioduret, in white swellings, with much benefit; *a third* has applied it with good effect in lupus; *a fourth* has laid it on cancerous surfaces, with good local, and no constitutional effects; and *a fifth* has seen it applied to ulcers about the toes, with much service (on Blicke and Abernethy's plan.)

Question XIII.

"Can you refer to any valuable papers or treatises on the medicinal use of arsenic, which may assist in the prosecution of this inquiry?"

In reference to the replies to this question, although, as I have already notified, I have unfortunately had neither time nor space at present to allow me to fulfil my original intention of collating and comparing the published records of arsenical treatment with the facts unfolded by this inquiry, yet I feel myself bound, not only to thank the gentlemen who have favoured me with many valuable references, but to subjoin, for the benefit of those who may wish to pursue the subject, the substance of

the replies I have received to this part of the inquiry, as well as to add a list which I had previously arranged for my own use.*

Question XIV.

"Can you mention any facts of interest occurring under your own eye, connected with the subject, not referred to in these questions?"

The replies to this question are numerous and interesting. They consist both of facts and opinions, which I shall present, as far as possible, in separate extracts.

Facts.—1. *Mr. Ancell's* experience of the use of arsenic was chiefly on the Ohio and Mississipi rivers, where he administered it extensively (in many hundreds of cases of intermittent and remittent fever.) "At that time," he adds, "quinine had not been brought into use. Powdered bark in port wine, or otherwise, was the remedy. The disease was most inveterate, the stomach would seldom tolerate a sufficient quantity of the medicine, and the disease continued five, six, or ten weeks, or longer. On suddenly setting aside the bark and taking to the white oxide of arsenic, the paroxysms were generally arrested in three days, and the patient very rapidly became convalescent." * * * "I first used Fowler's Solution, but frequently failed; I then used the arsenious acid, beginning with one-sixteenth of a grain three times a day, increasing it to one-eighth of a grain, and in some few cases even to a sixth."

2. *Mr. Arrowsmith* says, "In the *Medico-Chirurgical Transactions* of 1838 is a paper, by Henry Hunt, Esq., of Dartmouth, 'On the use of Arsenic in some Affections of the Uterus.' On reading this paper, I immediately gave arsenic an extensive trial in cases of too frequent and prolonged menstruation occurring to delicate women; and after prescribing it for ten years under such circumstances, I feel perfectly able to confirm all that Mr. Hunt has said in its praise. Mr. Hunt seemed to prefer the arsenious acid to the liquor arsenicalis, but I have given the latter preparation, being quite contented with it. I have found six or seven drops of the liquor, given every eight or twelve

* See Appendix.

hours, act like a charm, as compared with other remedies; and this I have often persisted in for three weeks or a month, without any untoward symptom."

3. *Dr. Barham* relates the following case:—"In one case of head-ache of a curiously periodical type, most nearly approaching to double quartan, in a female, aged 24, I attributed a slight pharyngitis with failure of strength and tendency to deliquium, which continued for a fortnight, to the use of moderate doses of liquor arsenicalis. As they did not recur subsequently to the discontinuance of the medicine, I see no reason to doubt the causation."

To Dr. Barham we are further indebted for the following account of the results of the cases which have fallen under his observation in the last ten years. They occurred at the Cornwall Infirmary, and were obligingly extracted from the hospital books by the assistant surgeon, Mr. Gorringe, at the request of Dr. Barham, both Members of the Association, and both deserving our best thanks:—

DISEASE.	No. of Males.	No. of Females.	Cured.	Failed.	Relieved.	Died.
Impetigo	2	5	5	2	...	...
Eczema	...	2	1	...	1	...
Erythema	...	1	1	...	...	...
Porrigo	2	3	2	1	2	...
Prurigo	1	...	1	...	...	...
Lichen	1	...	1	...	...	...
Sycosis	1	...	1	...	...	...
Psoriasis	8	7	9	1	4	1
Lepra	2	4	4	2	...	...
Eruptio	2	2	3	...	1	...
Lupus	...	2	1	...	1	...
Carcinoma	1	1	...	...	1	1
Scrofula	1	...	...	...	1	...
Lumbago	1	1	2	...	...	...
Neuralgia	1	2	1	1	1	...
Cephalalgia	...	3	1	...	2	...
Cephalalgia (Syphilitica)	2	...	2	...	...	...
Cephalalgia (Intermittens Febrilis)	1	...	1	...	...	...
Hysteria	...	2	...	1	1	...
Chorea	...	2	2	...	...	...
Menorrhagia	...	1	1	...	...	...
Paraphlegia	...	1	...	...	1	...
Vertigo	1	...	...	...	1	...
Total	27	39	39	8	17	2

"The cases of impetigo in which arsenic failed, were cured under the use of Liq. Potass., with inunction of Ung. Picis Liq. in one case, and Ung. Cetacei in the other. The case of porrigo in which arsenic failed, recovered under the use of Tinct. Cantharides and Tinct. Ferri Sesqui-chloridi, and a lotion of Sulphas Zinci. The case of psoriasis in which arsenic failed, recovered under the use of Liq. Hydr. Bichlor. and the inunction of Ung. Hydrarg. Nitratis. Hemiplegia was the precursor of death in the fatal case. The two cases marked as failures under lepra, occurred in the same individual, who presented herself a second time at the hospital, about two years from the date of the previous discharge. In both instances, after taking arsenic without benefit, she was speedily cured by the inunction of Ung. Picis Liq. On the first occasion she took Liq. Potass. Arsenitis, in gradually increasing doses; on the second, in gradually diminishing ones. In fact, it was necessary to suspend the medicine for a short time, from gastro-æsophageal irritation, and a small dose (two minims and a half) was afterwards borne; the eyelids were affected, but no improvement appeared in the disease. In the case of vertigo, in which arsenic failed, a cure was effected under the administration of Cupri ammonio-sulphas."

Dr. Barham further relates a case of cancer on the lip, which appeared to be permanently cured by the external application of arsenic with calomel, on Dupuytren's plan. The brother of the patient had died from cancer, originating in the same situation. Dr. Barham says:—"The influence of arsenic diffused in the air, is, I think, deserving investigation. The works for smelting copper, from which the vapourized arsenic is most extensively given off, have been removed from this country to Wales. When such works existed here, it was asserted that an almost entire immunity from fever was enjoyed by those who lived at all near them. Cattle were stated to have become crippled, and to have lost their hoofs within the range of the same influence. I have been told that the potato blight did not affect a considerable tract over which the arsenical influence extends in the neighbourhood of Swansea. In this district, the blighting of the foliage by the poison is said to be observable two or three miles from the chimneys, in the direction of the prevailing winds. Several years ago a man was obliged to abandon mining labour,

from what was regarded as hopeless consumption; he rallied in his new employment, and has now enjoyed good health for a long period."

A friend of Dr. Barham attributes his recovery from an intermittent febrile affection, contracted in India, and slightly returning in England for ten years together, to the vapours of arsenic, diffused in his apartments from some stearine candles which he used.

Dr. Elliotson has combined arsenic with hydrocyanic acid and creosote, to prevent the sickness occasioned by it.

Mr. Evan Evans does not remember any case, either of intermittent or cutaneous disease, in which the administration of arsenic did not ultimate in cure.

Mr. I. B. Brown has frequently succeeded in curing Essex intermittent fevers with arsenic, after the use of bark and quinine had failed.

Dr. Henry Cooper, of Hull, says he has substituted arsenic for antimony, in the preparation of tartar emetic, and given one-sixteenth of a grain of the salt (tartrate of arsenic and potass,) as a dose. It is more soluble than the arsenious acid.

Dr. Cowan says, "Practitioners in my neighbourhood are generally averse to what they term 'strong remedies,' and there is a popular objection to the idea of arsenic particularly. *From this springs a tendency to saddle it with all conceivable consequences,* and the *post hoc* argument is sure of its application." [*Query.* Is Berkshire the only county in England in which the progress of science is hindered by popular objections?]

Dr. William Dix writes, "During my apprenticeship in Norfolk, near the coast, the prevalence of ague was so great, that we have used in the year fifteen wine-quarts of Fowler's Solution, in a population of forty-five incorporated parishes (under Gilbert's act.) I have scarcely ever cured a case of intermittent fever, during a practice of nearly forty years, with any drug but arsenic, which I have administered with the most gratifying results."

Mr. Bainbridge gives the details of a case of secondary syphilis benefitted by arsenic, in a very satisfactory degree. Mr. Bainbridge was led to its adoption by the general coldness and chilliness of the surface, an indication which he and other correspondents have observed as favourable to the useful action of arsenic.

Mr. Brown, of Castle Donington, relates a case of lepra cured by arsenic. After a few doses had been taken, the patient complained of nausea; but this unpleasant effect was removed, by the drops being taken on the meals, instead of an empty stomach.

Mr. Girdwood relates that "A patient took two drachms of Fowler's Solution, in twenty-four hours, by mistake. It cured the ague, for which it was administered, (a tertian,) and it had no detrimental effect."

Dr. Heygate mentions the remarkable degree of success which attended the administration of arsenic during the years 1826–7–8–9, when ague was epidemic in this country. Six or seven hundred cases fell under Dr. Heygate's treatment, and he says: "The liquor arsenicalis I almost invariably found a speedy and effectual remedy. I certainly have found this solution succeed, when bark, quinine, and all other remedies have failed." It was administered always under the condition of previously correcting any foulness of the tongue which might be present; and remitted, if heat or thirst occurred during its exhibition. The dose was ten to fifteen minims.

Mr. Hunter says that in the fens of Lincolnshire, where arsenic is largely used, suicides are very frequent; the miasma is depressing, and the poison at hand. He also mentions, as well as Dr. Webster, De Valangin's Solution of the mineral, as having been a very popular formula half a century ago, and now again becoming fashionable. It is said to be a muriate, or hydro-chlorate of arsenic, and may be had at Apothecaries' Hall.

Mr. Hurd was for six years in a malarious neighbourhood, where arsenic had been long used for the cure of intermittent fever. The results varied. Where bark or quinine failed, arsenic (apparently,) succeeded, and *vice versa;* but *why,* was not at the time made out.

Mr. Matthew Jackson says: "The deuto-ioduret of arsenic, applied externally to splints in horses and to curbs, is a valuable application; and the arsenious acid will readily remove hanberries from the same animal."

Dr. Jones says: "I believe it (the Liq. Potassæ Arsenitis,) alters its strength by keeping; inasmuch as the bottle becomes coated with an opaque film, not soluble in water, but removable

by hydrochloric acid. It cannot be owing to the Tinct. Lavand. Comp., because the bottle in which that is kept is not so coated."

Dr. Paxton refers to a case of dry asthma, much benefitted by small doses of arsenic, which, however, does not appear to have been equally efficacious in other similar cases. He also suggests an indication as to the tolerance of arsenic, which will become most valuable if it should prove, upon extensive trials, to be worthy of reliance. My own observations, which have been especially directed to the question since the receipt of Dr. Paxton's letter, have, in some degree, confirmed it. He says,—"The quantity of arsenic it is prudent or necessary to administer to different individuals in some affections, depends *on the mode of life which the patient pursues.* In sedentary persons it seems to accumulate; for a very moderate dose, say eight minims twice a day, occasions serious derangement of the animal functions,—headache, and gastric pains, &c." Whereas those who take a great deal of active exercise, or live a laborious life, may take, without the smallest inconvenience, double or treble the dose. In proof of which he relates the case of a man who, by changing from a sedentary to an active employment, not only was able to take a double dose of arsenic, but was cured of the eruptive disease which the medicine had previously failed to remove. This fact, and the opinion founded upon the fact, and others of like nature, open a field of interesting inquiry, not only practical, as regulating the dose, but therapeutical, as tending to elucidate the *modus operandi* of this wonderful medicine. Is it to the air, or to the increased action of the capillaries, or to the relief of the nervous system, or to the augmented secretions, that we are to attribute the advantage gained?—or was it in each case accidental? All these questions can easily be brought to the test of experiment by practitioners enjoying, and bearing the responsibility of, public medical appointments.

Dr. Henry Payne appears to have prescribed arsenic with unusual success in obstinate agues, and equally obstinate cases of neuralgia. It proved a speedy cure in fifty cases, *in all of which,* other medicines had failed. The *first dose,* in many instances, removed the complaint; and in the others, this happened in the course of a few days. The Doctor gave from three to eight minims of Fowler's Solution three times daily, in cold

spring water, between the meals, with the same results in both hospital and private practice.

In whatever way these singular facts may be explained, one important lesson may be learned from Dr. Payne's experience, as compared with that of his brethren, viz: that no degree of success, or the want of it, occurring in the practice of a single individual, should be regarded as a satisfactory criterion of the medicinal action of any agent, much less of one unusually variable in its action. Had the truth of this position been duly appreciated by the profession, how much less should we now have to *unlearn!*

Mr. Parrott says he has used arsenic extensively for several years past, has had every reason to be satisfied with its results, and has never once had occasion to regret having employed it.

Mr. Stoneham says: "In a very aguish district, the poor wanted the 'drops,' not the 'doctor.'"

Opinions.—The following opinions expressed by different writers, must of course be regarded as of less value than well attested facts; but, considering the source from which they emanate, and the extensive experience on which they are for the most part founded, they will be regarded by the reader as too valuable to be lost.

Dr. Golding Bird writes: "I am glad, in your very interesting paper, that you have directed attention to the important fact of giving the arsenic *after a meal.* I have for years taught the opinion that when we wish a metal to be absorbed into the *general* circulation, it should be given mixed with the food: when only intended to enter the *portal* circulation, it should be given on an empty stomach. I have some reasons for these views. I believe the elements of the food, of a homogenic character, are absorbed by the lacteals, and not by the veins. On the other hand, the substances not forming part of the food, are (when in solution,) absorbed by the venous capillaries. Thus arsenic, or iron, in solution, and taken on a meal, so as to mix with the food, will be almost entirely absorbed into the chyle by the lacteals; but if taken on an empty stomach, the medicine will be chiefly absorbed by the venous capillaries, and enter the portal circulation. These facts are important points in practice, espe-

cially in the treatment of anæmia by iron, as they enable us to cure this condition more certainly and speedily, than without their aid."

Dr. Mervyn Crawford says he believes that the gastric irritation and constitutional disorder produced by arsenic (used medicinally,) have been "vastly exaggerated."

Mr. Salter, in a note accompanying his report, says: "I have long considered it (arsenic) one of the most valuable articles of the *Materia Medica,* and that the profession generally has evinced too much timidity in its use; and I must here add that I think you have conferred a great benefit upon your professional brethren and society, by bringing the subject of its employment prominently forward at this time."

Mr. Stoneham, Mr. Sweeting, and several other correspondents, allude to the accumulative property of arsenic, and urge the necessity of great caution in its use on this account.

Dr. Theophilus Thompson says: "I know nothing to compare with arsenic for efficacy, in that stage of eczema inpetiginodes, when the period of free secretion (which is benefitted by mineral acids,) has passed."

I have great satisfaction in adding to this testimony, that this important distinction has been of late abundantly confirmed in my own experience. This disease is often highly inflammatory, and is only curable by arsenic, after the vessels have thoroughly discharged their contents.

Dr. Webster writes as follows:—

Dulwich, March 1st, 1849.

My dear Sir,—I fear you will think I have forgotten my promise of sending you the formula for the preparation of arsenic, which has been long sold at Apothecaries' Hall as "The Mineral Solvent" of De Valangin. It was first brought under my notice some eight or ten years since by Dr. Farre, as a *milder* remedy, in a case of lepra under our care, than "Fowler's Solution." Being anxious to know the exact nature of the preparation, the Doctor very obligingly procured me the formula through the kindness of Mr. T. L. Wheeler, then Chairman of the Court of Examiners at the Hall. After I had the pleasure of seeing you last week, it occurred to me that as the formula had reached me in a semi-confidential manner, (though I felt sure that the authorities at the Hall never regarded it as a secret,) I was scarcely authorized to make it publicly known without their permission. I therefore wrote to Mr. Wheeler on the subject, who at once removed any scruples I might have had on this point, by stating that the recipe for this preparation, (which, with that for the Baume de Vie

or Decoct. Aloes Comp., was imparted to the Society by De Valangin,) might have been had at all times at the Hall.

The preparation, as you will see, is in fact, a hydrochlorate of arsenic, and may now be made in a more direct manner than that prescribed by De Valangin's formula. Dr. Farre spoke highly in its praise, and considered it much *milder* in its effect than Fowler's Solution. He said,—"He had been obliged to desist from the latter in Lepra Vulgaris, and cure by the former." Mr. Wheeler says,—"My experience is that it is far preferable to the Arsenite of Potass., inasmuch as I have found it a more direct tonic, and *altogether more manageable;* and if time and space would allow, I could dilate on this part of the subject."

In the few cases in which I have had the opportunity of using it, it acted as efficaciously as the alkaline preparation, producing what may be called the specific effects of arsenic on the constitution and the eyes, but in a milder degree; and it certainly, *cæteris paribus*, agrees better with the stomach. One lady, whose stomach was highly sensitive to very small doses of the Liq. Pot. Ars., could bear larger doses of the Liq. Hydrochlor. Arsen. with impunity.

Some remedies agree much better with the stomach, and the system generally, when combined with mineral acids than with alkalies or vegetable acids. The hydrochlorate of morphia is a good example. One patient of mine suffered severely from all the usual preparations of opium, including Battley's Liq. Opii. Sed., and the acetate of morphia, and could detect the smallest quantity when given; yet she could bear the usual dose of the hydrochlorate of morphia with the best effects. I hope, therefore, that the hydroclorate of arsenic will be introduced more generally into practice, and find a place in the next edition of the Pharmacopœia, which, I trust, will be a national one.

I am sorry that I cannot give you any *statistical* information respecting the use of arsenic, for I was early prejudiced against it when attending the lectures of the celebrated Professor James Gregory, of Edinburgh, who thought it could not be given for any length of time without most injuriously affecting the constitution. It is only in later years that I have employed it in neuralgia and skin diseases, and with a freedom which I at one time did not anticipate. I have cured intermittent neuralgia, or brow ague, with arsenic, when quinine has failed; and lepra, eczema, &c., when nothing else would cure; and I am happy to add, that I never saw any permanent injurious effects from its use.

Yours, very faithfully,

GEORGE WEBSTER.

To Thomas Hunt, Esq.

[*Copy of the original Formula for preparing De Valangin's Mineral Solvent.*]

Take of White Arsenic, lb iij.
Common Salt, lb. viij.
Sublime in a bolt head.
Take of this Sublimate, ℥j. gr. xxxii.
Muriatic Acid, (sp. gr. 1,788) lb. ij ¼.
Distilled Water, 2 gallons.

Dissolve the Sublimate in a little of the Acid and part of the Water in a Florence flask, then add the rest of the Water, and mix thoroughly.

Apothecaries' Hall, London, July, 1842.

Lastly, a gentleman, whose name I much regret I am bound to suppress, but whose experience in arsenic is, I believe, far greater than my own, speaks both of its efficiency and safety, in far stronger terms than any other correspondent. He says: "I regard it as invaluable. I would sacrifice nine-tenths of the *Materia Medica* for arsenic. This, however, I state *privately*, for the prejudice against it is very strong, and I have neither time nor inclination to become its champion." The reluctance with which this concession is made, or rather the air of secrecy with which it is communicated, proves its genuineness. This very cautious practitioner is by no means singular. I am acquainted with several who prescribe, or rather dispense, arsenic very largely for almost every form of chronic disease, but who dare not avow it, even to the profession. It has been confidently asserted that the late Mr. Scott, of Bromley, was chiefly indebted for his unparalleled success in the treatment of local disease, to his very extensive but not indiscriminate use of arsenic, which was generally disguised in sarsaparilla decoction.

DIGEST OF THE ABOVE REPLIES.

It will be my aim in presenting a digest of the facts contained in the above replies, so to embody them, as to render them practically useful. Here is a medicine which is potent and effective in no common degree, but yet very little used by the profession. Is it desirable that it should come into more general use? or are there circumstances which forbid it? These questions will be best replied to, by inquiring into the proofs afforded by the foregoing testimony, of its safety, its efficiency, its adaptation to disease or constitution, and various other circumstances. It will be convenient to begin with those questions, the replies to which are founded on the clearest demonstration, and afterwards to proceed to those in which the evidence is less clear, concluding with a review of those portions of the replies which are merely matters of opinion.

I. The first, and perhaps the most important point which is absolutely demonstrated in this correspondence, is that *arsenic is a safe medicine*, no correspondent having found it either fatal,

or permanently detrimental to the health. To this it may be added that in moderate doses, it seldom or never appears to have superinduced symptoms of a grave character, even for a short period. If the attack of mania, related by Mr. Fox, was in any degree the result of the administration of arsenic, which is exceedingly doubtful, it must be remembered that the patient, an hysterical (susceptible) female, took no less than twenty drops of Fowler's Solution, four times a day, or eighty drops every twenty-four hours. This dose was not prescribed by Mr. Fox, but by a physician whose name does not appear, and therefore I do not hesitate to say that if it had been *fatal*, no discredit would have rested on the medicine, but grave responsibility would doubtless have been incurred by the physician who prescribed a dose at least four or five times larger than appears to have been nccessary. In the case related by Dr. Theophilus Thompson, the patient indiscreetly persevered, for more than three months, with eight-minim doses of Fowler's Solution, three times a day, *after stiffness of the eyelids and nausea had been produced.* Violent vomiting, perspirations, and coloured urine occurred in this case, doubtless the result of arsenic continued in very large doses long after the well-known premonitory symptoms of an overdose had supervened — a very instructive case, but not a case in any degree opposed to the general testimony to the safety of arsenic in moderate doses, decreased as the tarsi become affected; the case being closely watched.

It is plain, however, that the safety of the medicine must depend upon the *dose*, and this again upon its adaptation to the age and constitution of the patient; and in connexion with this important point, the question whether there is much *variableness* in the effects of arsenic in different cases, becomes very interesting. It will therefore be desirable to examine the evidence upon these two points consecutively.

1. The *dose* which has been given by the different respondents varies exceedingly. Taking Fowler's Solution for the formula, (the one used by a large majority of practitioners,) it appears that one practitioner begins with a minim of the solution thrice a day, gradually increasing to five. Another begins with ten minims thrice a day, gradually increasing to twenty; and between these extremes a great variety of doses are mentioned, the average

being about five or six-minim doses three times a day: but many mention that much larger doses are borne and required in intermittents, than in cutaneous and other chronic disorders which have not this character.

2. The *variableness of its operation* has not been noticed at all by *seventeen* correspondents. *Fourteen* have found its action variable: of these, *one* has met with "very great" variableness; *another*, with "considerable" variableness; a *third*, with "not much;" a *fourth*, "but little;" by *one* mention is made of great difference in its tolerance in different cases; and *one* gentleman observes that, "as might be expected, females seem more susceptible of its irritating tendency than males."

Upon the whole, the evidence shows (1.) that there is greater variableness in the action of arsenic in different persons than in the action of perhaps any other mineral; or, in other words, its influence is more liable to be modified by idiosyncracy than that of other medicines of the same class: a fact which shows the necessity of giving the medicine in doses as small as are found to be efficient, and watching its effects carefully. And it may be noted that the same variableness of action has been observed in cases where the mineral has been used in large doses as a poison. (2.) It appears that the variable action of arsenic in different persons presents no solid objection to its general use; inasmuch as the cases in which the system is in a great degree intolerant of the mineral, are exceedingly few; and in these few this peculiar susceptibility may be soon discovered by administering an average dose, a few repetitions of which will reveal the truth; and if the dose be then decreased proportionably to its effects, it will be borne with impunity, and will generally control diseased action in such cases, as readily in reduced doses as in ordinary cases in full doses. (3.) It appears that in many cases it has been administered, even in large doses, for weeks and months together, without giving any sign of its presence; and this has happened so frequently, and in the hands of so many (at least fifteen) different observers, that it is impossible to attribute the circumstance either to the impurity of the medicine, or to any error on the part of the patient, or misapprehension on the part of the practitioner. The facts are, indeed, corroborated by the general evidence of variable susceptibility, and present

only the extreme links in the chain. The practical deductions are important. Larger doses would, doubtless, in such cases, be more efficient, but the known cumulative action of the medicine presents an objection to the practice of increasing the dose, and rather justifies a long-continued perseverance in moderate doses. I have myself observed that the permanent power of the medicine, in preventing relapses of cutaneous disease, is more conspicuous in cases where it has acted thus slowly, than when the system has suddenly yielded to its influence.

II. With regard to the *efficiency of arsenic in various diseases:* although two or three of our respondents have been generally disappointed in their expectations, and one attributes his success to *time;* nevertheless, the replies present overwhelming evidence of its utility; and in many cases the evidence is absolutely demonstrative, the disease having recurred on the abandonment of the medicine, and regularly yielded to every successive course.* The synopsis (page 393,) will show at a glance the diseases in which its efficacy has been most observable. It appears, from this table, that arsenic has been chiefly prescribed in cutaneous and intermittent diseases and in neuralgia, and that it has been by far more frequently used in the *various chronic forms of non-contagious skin disease* than in any other disorder. The success attending its use in these affections has been various, but quite sufficiently demonstrative and extensive to signalize the mineral as *the* medicine for cutaneous disease. In *intermittents* its effects are more uniform, and in neuralgia scarcely less so. Indeed it appears that in *intermittent neuralgia* it seldom or never fails;—that in ague, of whatsoever type, quinine will rarely fail alone, and arsenic alone will rarely fail; but when one fails, the other will often succeed:—and a combination of *both* remedies in full doses will never fail in intermittents. This opinion is confirmed by the observations of several correspondents.

Of the other diseases enumerated in the foregoing table, how many, alas, have eluded all our efforts! Is it too much to add,

* Mr. Andrews says he has generally attributed the cure in eruptive diseases to *time*, although he has been continuing the arsenic. Mr. Cassels, on the other hand, says, "In several cases of lepra the disease has been apparently cured, but returned after many months, when the arsenic has again been given *with the same result.*"

that in no one of these affections should the case be abandoned, without a fair trial of arsenic? This question naturally introduces another important inquiry, viz. :—

III. What are the peculiar circumstances, in any given case, which would justify the administration of arsenic; and what are those which should be taken to interdict its use?

This is a most important practical inquiry; but although it is my duty to present the evidence, I confess that it is not entirely demonstrative, the line of demarcation which separates facts from opinions being by no means distinct. I could wish, indeed, that this difficult digest were in abler hands. I do think, however, that by faithfully analysing both facts and opinions, the following conclusions would appear to the general professional mind, quite as satisfactory as the grounds on which we are usually accustomed to act in practice.

(1.) The most zealous advocate for the use of arsenic will scarcely refuse to subscribe to the following postulate, viz. :—Let it be granted that arsenic, being a dangerous and deadly poison, and, moreover, exceedingly variable and uncertain in the energy of its action on different individuals, *should never be administered in any case in which other medicines, less objectionable, are likely to prove equally efficacious.* To this rule I invariably adhere in my own practice. Still it must be admitted that the rules of medical practice are not absolute, and we may readily conceive of exceptions to this. Quinine, when pure and exhibited in sufficiently large doses, is perhaps as certain a remedy for intermittents as arsenic; but in marshy and malarious districts it is evident that thousands of the poorer classes afflicted with ague must remain uncured, unless a cheaper remedy than quinine can be found: and seeing that, under proper restrictions, arsenic is a safe and generally an efficient remedy, who shall be found to censure its adoption? The Union Surgeon must be much better paid than he now is, before any one can blame him for using the cheaper drug. And in the case of children, with whom arsenic generally agrees very well, and who can scarcely be induced to take nauseous drugs in sufficient quantities, it may be very justifiable to substitute arsenic for quinine.

(2.) *A passive condition of the circulation is favourable to the*

exhibition of arsenic, and, *vice versa*, whenever there is an abnormal degree of power in the pulse, its use in contra-indicated, more especially if there be a hot skin and suppressed secretions, or an irritable condition of the mucous membranes. The following different descriptions of the condition of system, in which its action has been found favourable, will confirm the above remark. I quote the expressions (as concisely as possible) in which various correspondents have conveyed this idea:—"In the phlegmatic, rather than the sanguine temperament;" "In cachectic, lax-fibred habits;" "In debility;" "In the atonic state of the system;" "In general pallor;" "Slow circulation;" "General coldness;" "Non-inflammatory condition;" "Freedom from febrile, or mucous irritation." I commend these valuable hints to the consideration of the practitioner. I have generally found, however, that arsenic is well borne, even in plethoric habits, if the pulse be first of all reduced to a soft compressible condition, by evacuants and a spare, non-stimulating diet. In opposition to this, several correspondents aver that a "tonic condition," "the sanguine temperament," "a plethoric habit," and a "proneness to irritability of the circulative and assimilative systems," are circumstances which, in their experience, severally contra-indicate its use. Other respondents add, "where the lungs are unsound," where there is observable "natural irritability of the mucous membranes," "an inflammatory tendency," "acute disease," "head symptoms," "eczema mercuriale," "organic disease," or "tendency to sudden nervous exhaustion." Here again are suggestions, rich in instruction, and full of practical interest.

IV. Assuming that arsenical treatment is indicated in a given case, what are the signs of an overdose?

The signs enumerated may be divided into two classes, viz.: the vascular and the nervous. The vascular signs, or those which betray an increased momentum in the circulation, are as follows:—"Conjunctivitis," "swelling of the limbs or features," "irritation of mucous membrane," "purging," "gastritis," "desquamation of cuticle," "general inflammatory state," and "flushings." The nervous signs, or those which betray disordered sensation or excitement of the nervous system, are described as "headache," "exhaustion," "restless nights," "sinking," "giddiness," "palpi-

tations," and "mental agitation and alarm." The order in which these symptoms appear, and the influence they should exercise in practice, are variously stated. "Conjunctivitis" is certainly named most frequently as the sign of an over-dose, although one gentleman has never observed it. In fact, it is frequently so slight as to elude observation; but its importance consists in this circumstance, that it is not so likely as the other signs to be otherwise caused. The other mucous membranes are so frequently excited by cold and other causes, that it is often impossible to determine their origin; whereas the arsenical conjunctivitis is a special affection, less violent by far than the strumous inflammation of the tunic, and marked by itching of the tarsi, increased secretion, puffiness of the lower eyelid, and if this be everted, the membrane presents a horizontal red streak, perfectly characteristic; as much so, indeed, as the mercurial affection of the gums. The various affections of the nervous system, considered as signs of an over-dose, are equally vague as those of the circulation. They are often produced by the *idea* of being poisoned. I have myself found it both safe and useful to regard them but little, until their origin becomes demonstrated by the peculiar red streak on the portion of the conjunctiva lining the lower eyelid. Two or three other symptoms, not easily classed, are mentioned, viz: "tympanitis," "emaciation," and "sickness." They appear to be rare.

V. What is to be done when the signs of an over-dose are manifest?

Almost every correspondent thinks it best to discontinue the medicine; some for a period, others altogether. Here, I may be allowed to suggest, is a wide field for improvement. It is rarely necessary to break off the course, much less to abandon the use of the medicine; but the dose should be gradually reduced, and the curative action will be safely sustained. The truth of this I have now proved in several hundreds of cases. The value of arsenic will never be fully known until this practice is universally adopted.

VI. How far are the effects modified by the mode of administration in respect to the meals?

I cannot say that the reports are so satisfactory on this point as I had been led to expect. I have generally found that if the medicine is given *fasting,* gastric symptoms are among the earliest intimations of an over-dose; but when mixed with the food, or taken immediately after a meal, it seldom offends the stomach. Out of twenty-nine gentlemen who have given it fasting, fifteen report the appearance of gastric symptoms. Of nineteen practitioners who have exhibited the mineral on a full stomach, ten have observed gastric symptoms; the proportions, therefore, are nearly equal.

VII. With respect to the purity of the preparation in general use, I was once induced to suspect, from the apparent variableness resulting from its exhibition, that the *liquor potassæ arsenitis* was frequently adulterated. Farther inquiries, aided by the reports in my hands, have modified this opinion as to the present condition of the solution sold by druggists. The progress of science has prevented the mistakes formerly of common occurrence; and, with the exception that it is sometimes met with *stale,* the compound spirit of lavender having lost its fresh odour, I believe it is pure, usually containing the proper proportion of arsenic. The variableness of its action appears to depend on idiosyncracy. The cause is found in the patient, not in the drug; and this opinion is confirmed by the fact, that although the evidence of its purity varies in different reports, *there is no corresponding discrepancy in the description of its effects.*

The reader is now in possession of the best abstract view of the reports which my ingenuity can furnish, and will form his own opinion of their value, and of the use to be derived from them. My own experience of arsenic is *not* included in this memoir, but I may be permitted to add, that since I first published my views of its efficacy in chronic cutaneous diseases, my attention has been directed to its use, uncombined and systematically administered in certain *other* diseases which have hitherto been regarded by common consent as absolutely incurable, such as cancerous and fungoid affections. Knowing how extremely fallacious mere individual experience always must be, I am positively afraid to make known, at present, the degree of success which

has hitherto attended these experiments, as it may have been, and probably is, fortuitous; but there is an interesting field of inquiry open to the Members of the Association in this department. Let such a disease as cancer, or any adventitious growth in its earlier stages, be treated with arsenic internally, on the conditions of administration which this memoir demonstrates as most favourable for its action. Let the treatment be persisted in, nothing forbidding, for three months. Let the case be then left to nature for three months, and the arsenic resumed for a like period, and again let its use be remitted, watching the case closely, and avoiding, as far as possible, all disturbing influences. Each case *must* tell an instructive tale. Let the details be noted in a case-book, always in the presence of the patient, lest the memory prove treacherous. *Let every Member of the Association, and every professional reader,* be persuaded to pursue this plan for twelve months, having the notes ready for delivery whenever the Association shall ask for them, and in less than two years from this time the profession will have gained a valuable increment of practical knowledge, whilst the patients so treated, I will undertake to say, will have no cause to complain that they have been tampered with, or that they would have fared better under the routine practice of the day.

In conclusion, I have to express my sincere regret that my laborious, but grateful task has been so imperfectly executed, and to apologise to my brethren for any inadvertent errors or omissions which the heterogeneous mass of valuable matter in my hands has probably rendered inevitable. The original letters will be carefully preserved and deposited wherever the Association shall see fit to direct, in order that any want of accuracy may be corrected, and that any member may be able to ascertain how much he, as well as the humble compiler, is indebted to his brethren for their valuable contributions to the bewildering science of therapeutics.

APPENDIX.

Publications and papers relating to arsenic, alluded to under Question XIII., and referred to by various correspondents:—

"Medical Essays and Observations," vol. iv, page 45. (Edinburgh, 1757.)

"Medical and Chirurgical Review, or Compendium of Medical Literature," vol. xiii, page 210, 211; 1806. Also vol. xii and xiv.

Van Swieten's "Commentaries." (See the references in the last volume.)

Mead, "On Poisons."

"Medico-Chirurgical Transactions," vol. xxi; 1838. "On the use of Arsenic in some Affections of the Uterus." By Henry Hunt, Esq., of Dartmouth.

Ibid, vol. iv, Paper by Mr. Martin, of Reigate.

Ibid, vol. x, Paper by Mr. Salter, of Poole.

Hunt, "On Diseases of the Skin." (1847.)

"Dictionnaire de Médicine." Article, "Bibliographie," (lately published in Paris,) which contains the title of many works on arsenic.

Rayer's "Traité des Maladie de la peau."

Dr. Heygate, "On Tic Doloureux, or Neuralgia." (Edinburgh, 1836.)

Ferriar's "Medical Histories and Reflections," vol. iii.

Beck's "Medical Jurisprudence," seventh edition, contains references to nearly every book and paper that has been written on the subject.

Dr. Jaeger's "Dissertatio inaug. de effectibus Arsenici in varios organismos," &c.

Mr. Dendy, "Papers, read at the Medical Society of London." [Mr. Dendy obtained the Fothergillian Medal for a paper on "Lepra and Psoriasis."]

Bell, "On the Teeth," first edition, page 318.

"Lancet," May 5, 1832. Paper by Dr. Elliotson.

"Zoist," Nos. 16 and 18.

The following references, taken chiefly from Merat and Dehens's *Dict. Universel de Matière Médicale et Therapeutique Générale*, tome i, page 445, are kindly supplied by Mr. Crompton, of Manchester, viz.:—

Sperling, P. G., "Diss. de Arsenico," 4to. June, 1685.

Wedel, G. W., "Diss. de Arsenico," 4to. June, 1719.

Macquer, "Mem. de l'Acad. R. des Sciences." 1746 et 1748.

Jacobi, J. C., "De prudenti Arsenici sale alkalino usu interno salutari." 1751. ("Acta Acad. Moguntinæ," i, 216. 1757.)

Kuppermann, "Diss. de Medicamentorum ax auripigmento præparatorum præstantissimo usu Medico," 4to. (Hull, 1738.)

Dehenne, "Obs. sur les effets de l'oxyde d'antimoine contre l'Arsenic." ("Journal de Médicine," x, 330. 1759.)

Lefebure de St. Ildephont, "Remède approuvé pour guérir radicalement le cancer," 8vo. Paris, 1774.

Willan, "London Medical Journal," No. 14. 1786.

Fowler, "Medical Reports," 8vo. (1786.)

Fauve's "Rech. cliniques sur les effets de l'Arsenic dans le traitement des fièvres intermittentes," 8vo. (Paris, 1804.)

Desgrange's "Usage de l'Arsenic dans la Médecine interne." "Journal Générale de Médicine," xxx, 241 and 353. 1807.

Thiebault, C., "Reflexions sur l'Arsenic considéré comme medicament." (*Ibid*, xxxii, 5.)

Kielmeyer; "Diss. de effectibus Arsenici in varios organismos, necnon de indiciis quibusdam veneficii ab Arsenico illati," 4to. (Tub., 1808.)

Jaeger, G. F. J., "Diss. inaug. de effectibus Arsenici." (Tub., 1808. Citeé par M. Orfila.)

Fodéré, "Sur les Propriétés Médicales de l'Arseniate de soude," &c., 8vo. (1809.)

"Journal Générale de Medicine," xxxvii, 191, 297, and 393.

Fodéré, "Plusieurs Articles sur l'usage des preparations arsenicales en médecine." ("Journal Complimentaire," tome i.)

Harless, C. F., "De Arsenici usu in Medicinâ." (Bonn, 1811.)

Rapp, "Diss. inaug. de venevicio Arsenicali et ejus detectione." (Tub. 1817.)

Patrix, E., "L'art d'appliqur la pâte Arsenicale," 8vo. (Paris, 1816.)

Tachet, "Sur les effets de l'Arsenic sur l'Economie Animale." (Paris, 1818.)

Peudefer, H., "Sur l'emploi de l'Arsenic dans la Médicine," 4to. (1819.)

Arnold, "Diss. de veneficio Arsenicali." (Berlin, 1820.)

Fourcade-Prunet, J. G., "Sur l'oxyde blanc d'Arsenic," 4to. (1821.)

"Guelin's Apparatus Medicaminum," i, 250, 278.

"Reussii Repertorium Commentatum." ("Materia Medica," 232, and suiv.)

"Edinburgh Medical and Surgical Journal" contains many papers on arsenic, (see vols. v and vi, and see also Index to the first 20 vols.) These papers are very important.

The following references have been marked by the compiler for his own use:—

Mr. Erichseon, "On the Employment of Arsenic in the Treatment of Diseases of the Skin." "Medical Gazette."

"Practical Compendium of Diseases of the Skin." By Dr. Jonathan Green.

"Case of Chorea, treated by Arsenic." By Dr. George Gregory. "Medico-Chirurgical Transactions," vol. xi, page 299.

Various Papers "On Cutaneous Affections," by Mr. Horne. "Lancet."

Mr. Startin's Lectures "On Diseases of the Skin." "Medical Times."

Bateman's "Synopsis of Cutaneous Diseases." Edited by Dr. A. T. Thompson.

Dr. Robert Willis's translation of "Rayer on the Skin."

Mr. Erasmus Wilson's "Treatise on the Skin," and other works on the subject.

"The Anatomy of Suicide." By Dr. Forbes Winslow.

"Cases in which Arsenic was productive of Ptyalism," by Mr. Farley. "Medical Gazette" 1835.

Gibert, "On Diseases of the Skin."* Translated by Mr. Edgar Sheppard.

* Every Treatise on Diseases of the Skin appears to contain something on Arsenic.

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Turner, Thomas, Esq., Surgeon to the Royal Infirmary, and Lecturer on Anatomy and Physiology, Manchester.
Turnour, Arthur E., M.D., Denbigh.
Turton, George, Esq., Surgeon Accoucheur to the Dispensary, and Lecturer on Materia Medica and Midwifery at the Medical Institution, Sheffield.
Tutin, Septimus, Esq., Surgeon, Ripon, Yorkshire.
Tweedale, John, M.D., Lynn-Regis, Norfolk.
Twining, ——, Esq., Surgeon, Hull, Yorkshire.
Twynham, T., M.D., Winchester.
Tyacke, Nicholas, M.D., Physician to the Infirmary, Chichester.

U.

Underhay, Samuel Fowler, Esq., Surgeon, (late of Bath.)
Underwood, Charles, M.D., Ross, Herefordshire.
Underwood, J., M.D., Castletown, Isle of Man.
Underwood, John, Esq., Surgeon, Battle, Sussex.

V.

Valentine, John, Esq., Surgeon, Somerton, Somerset.
Varenne, Ezekiel George, Esq., Surgeon, Kelvedon, Essex.
Vaughan, Lewis, Esq., Surgeon, Builth, Breconshire.
Veasey, H., Esq., Surgeon Woburn, Bedfordshire.
Vicary, George, Esq., Surgeon, Warminster, Wilts.
Vicary, George Thomas, Esq., Surgeon, Warminster, Wilts.
Vidal, Horace, Esq., Surgeon, Ilfracombe, Devon.
Vinall, Charles, M.D., Sutton-Valance, near Maidstone, Kent.
Vincent, S. B., Esq., Surgeon, Botsdale, Suffolk.
Vines, Charles, Esq., Surgeon, Reading, Berks.
Vise, Charles, Esq., Surgeon to the Dispensary, Spalding, Lincolnshire.
Vise, E. B., Esq., Surgeon, Holbeach, Lincolnshire.
Vorley, Ebenezer, Esq., Surgeon, Roade, near Northampton.

W.

Wadams, Edmund, Esq., Surgeon, Malvern, Worcestershire.
Waddell, Cornelius, Esq., Surgeon, Stafford.

Waddington, Edward, Esq., Surgeon, Epworth, near Bawtry, Yorkshire.
Wagstaff, Philip Wynter, Esq., Surgeon, Leighton-Buzzard, Bedfordshire.
Wainwright, Thomas, Esq., Surgeon, Barnsley, Yorkshire.
Wake, Robert, M.D., Honorary Physician and Surgeon to the Dispensary, Southwold, Suffolk.
Waldron, Henry, Esq., Surgeon, Theale, near Reading, Berks.
Waldron, George, Esq., Surgeon, Bath.
Wales, Robert, Esq., Surgeon, Wisbeach, Cambridgeshire.
Wales, T. Garneys, Esq., Surgeon, Downham-Market, Norfolk.
Walford, T. L., Esq., Surgeon to the Dispensary, Reading, Berks.
Walker, David Grant, Esq., Surgeon, Budleigh-Salterton, Devon.
Walker, Edward Dering, M.D., Extra-Licentiate of the Royal College of Physicians, London, Teignmouth, Devon.
Walter, Hugh Eccles, M.D., Chesterfield, Derbyshire.
Wallace, Edward, Esq., Surgeon, Carshalton, Surrey.
Wallace, James, Esq., Surgeon, Carshalton, Surrey.
Wallace, Robert Q., Esq., Surgeon, Wisbeach.
Wallis, C. C., Esq., Surgeon, Castle Cary, Somerset.
Wallis, Edward, Esq., Surgeon, Lecturer on Anatomy, Hull, Yorkshire.
Wallis, Frederick, Esq., Surgeon, Bexhill, near Battle, Sussex.
Wallis, George, M.D., Senior Physician to the Infirmary, Bristol.
Wallis, William, Esq., Surgeon, Hartfield, Tunbridge Wells, Kent.
Walsh, John Henry, Esq., F.R.C.S., Surgeon to the Eye Infirmary, Worcester.
Walsh, Thomas, Esq., Assistant Surgeon to the Eye Infirmary, Worcester.
Walter, Frederick, Esq., Surgeon, Liverpool.
Walton, Henry Christmas, Esq., Surgeon, Liverpool.
Ward, Thomas, Esq., Surgeon, Southampton.
Ward, Thomas Ogier, M.D., 9, Leonard Place, Kensington, London.
Ward, W., Esq., Surgeon, F.R.C.S., Huntingdon.
Ward, ——, Esq., Surgeon, Stowmarket, Suffolk.
Ward, John, Esq., Surgeon, Bodmin, Cornwall.
Ware, John, Esq., Surgeon, Clifton, Bristol.
Warren, Henry, Esq., Surgeon, Knighton, Radnorshire.
Wase, Jeremiah, Esq., Surgeon, Yoxford, Suffolk.
Washbourne, Thomas, Esq., Surgeon, Corsham, Wilts.
Waters, Allen, Esq., Surgeon, Exmouth, Devon.
Watkins, Robert W., Esq., Surgeon, Towcester, Northamptonshire.
Watmough, I., M.D., Pocklington, Yorkshire.
Watson, George Churchill, M.D., (Edin.,) Liverpool.
Watson, James, M.D., Bath.
Watson, James E., Esq., Surgeon, Ellesmere, Salop.
Watson, Thomas Sandon, M.D., Physician to the Bath Hospital, Bath.
Watts, John, M.D., Daventry, Northamptonshire.
Watts, Thomas Hodgson, M.D., Physician to the Manchester Royal Infirmary, Manchester.
Waylen, W., Esq., Surgeon to the Essex and Colchester Hospital, Colchester.
Webb, Charles, K., Esq., Consulting Surgeon to the Devon and Exeter Lunatic Asylum, Exeter.
Webb, Matthew, Esq., Surgeon, Wellington, Salop.

Webber, Alexander, E., Esq., Surgeon, Wellington, Somerset.
Webster, George, M.D., President of the British Medical Association, Dulwich, Surrey.
Webster, J. H., M.D., (Cantab.,) Cambridge.
Weddell, W. B., Esq., Surgeon, Otley, near Leeds.
Weekes, George, Esq., Surgeon, Hurst-Pierpoint, near Brighton, Sussex.
Weekes, Henry, Esq., Surgeon, Bromptom, Kent.
Welsh, W. H., M.D., Eccles, near Manchester.
Welshman, Edward, Esq., Surgeon, Southam, Warwickshire.
West, John Townsend, Esq., Surgeon, Shepton-Mallett, Somerset.
West, John Wickens, M.D., Poole, Dorset.
West, Robert Uvedale, Esq., Surgeon, Hogsthorp, near Alford, Lincolnshire.
West, William Corner, Esq., Surgeon to the Dispensary, Malvern, Worcestershire.
Westall, Edward, Esq., Surgeon, Croydon, Surrey.
Whatman, James, Esq., Surgeon, Maidstone, Kent.
Wheeler, C., M.D., (late of Southampton.)
Whicher, James, Esq., Surgeon, Petersfield, Hants.
Whimper, G., Esq., Surgeon, Tillingham, Essex.
Whitcombe, Edmund Bancks, Esq., Surgeon, Cleobury-Mortimer, Salop.
White, G. M., Esq., Surgeon to the General Hospital, Nottingham.
White, R., Esq., Surgeon, Portsmouth, Hants.
Whitehead, James, Esq., Surgeon to the Manchester and Salford Lying-in Hospital, Manchester.
Whitby, George, Esq., Surgeon, Swaffham, Norfolk.
Whitfield, E., Esq., Surgeon, Tolleshunt-D'Arcy, Essex.
Whitfield, Henry, Esq., Surgeon, Ashford, Kent.
Whiting, J. B., Esq., Surgeon to the Lynn and West Norfolk Hospital, Lynn-Regis, Norfolk.
Whiting, John, M.D., Member of the Royal College of Physicians, Physician to the West Norfolk and Lynn Hospital, &c., Lynn Regis, Norfolk.
Whittaker, J., M.D., Ballina, Mayo, Ireland.
Whitton, Corbett, M.D., Banbury, Oxfordshire.
Whytehead, Henry Yates, M.D., Crayke, near York.
Wickenden, Joseph, Esq., Surgeon, Birmingham.
Wickham, John C., Esq., Surgeon, Tetbury, Gloucestershire.
Wickham, J. M., Esq., Surgeon, Sutton-Scotney, Hants.
Wickham, W. J., Esq., Surgeon to the Hospital, Winchester.
Wickham, W. N., Esq., Surgeon, Winchester.
Wight, Alexander, Esq., Surgeon, Old Kent Road, Southwark, London.
Wightman, J., Esq., Surgeon, Cawood, Selby, Yorkshire.
Wild, James, Esq., Surgeon, Sheffield.
Wilding, Richard, Esq., Surgeon, Church Stretton, Salop.
Wilding, R., Esq., Surgeon, Blackburn, Lancashire.
Wiles, S. B., Esq., Surgeon, Attleburgh,Norfolk.
Wilkes, George Frederick, Esq., Surgeon, Ashford, Kent.
Wilkin, Henry, Esq., Surgeon, Walton, Suffolk.
Wilkinson, H., Esq., Surgeon, Rotherham, Yorkshire.
Wilkinson, M. A. Eason, M.D., Physician to the Manchester Royal Infirmary, Manchester.

Wilkinson, Joseph Sheldon, Esq., Surgeon, Great Marlow, Bucks.
Wilkinson, William Cradock, Esq., Surgeon to the Dispensary, Spalding, Lincolnshire.
Wilks, Charles, Esq., Surgeon, Charing, Kent.
Williams, Abraham Jones, Esq., Surgeon, Pwllheli, Carnarvonshire.
Williams, Caleb, Esq., Surgeon to the Retreat, and Lecturer on Materia Medica in the Medical School, York.
Williams, Charles J. B., M.D., F.R.S., Fellow of the Royal College of Physicians, 7, Holles Street, Cavendish Square, London.
Williams, Edward, M.D., Senior Physician to the Colchester and Essex Hospital, Colchester.
Williams, Edward, Esq., Surgeon, Wrexham, Denbighshire.
Williams, Henry, Esq., Surgeon, Llansaintfraid, near Conway, Carnarvonshire.
Williams, Hugh, Esq., Surgeon, Thrapston, Northamptonshire.
Williams, John Calthrop, M.D., (Edin.,) Fellow of the Royal College of Physicians of Edinburgh, Physician to the General Hospital, near Nottingham, and Visiting Physician to the General Lunatic Asylum, Nottingham.
Williams, John, M.D., Beverley, Yorkshire.
Williams, John, Esq., Surgeon, Bewdley, Worcestershire.
Williams, John, Esq., Surgeon, Dursley, Gloucestershire.
Williams, Owen W., M.D., Southampton.
Williams, Peter, Esq., Senior and Consulting Surgeon to the Flintshire General Dispensary, Holywell.
Williams, Philip Henry, M.D., Physician to the Dispensary, Worcester.
Williams, Richard Lloyd, M.D., F.R.C.S., Consulting Surgeon to the Denbighshire Infirmary, Visiting Physician to the North Wales Hospital for the Insane, Denbigh.
Williams, R. P., Esq., Surgeon, Truro, Cornwall.
Williams, William, Esq., Surgeon, Guilsborough, near Northampton.
Williams, William, Esq., Surgeon, South Brent, Somerset.
Williams, William Rumsey, Esq., Surgeon, Carnarvon.
Willis, E. B., Esq., Surgeon, Soham, Cambridgeshire.
Wills, George Frederick, Esq., Surgeon, Crewkerne, Somerset.
Wilson, Daniell, Esq., Surgeon, (late of Hull.)
Wilson, F. H., Esq., Surgeon, Rye, Sussex.
Wilson, George, Esq., Surgeon, Monmouth.
Wilson, Henry, Esq., Surgeon, Runcorn, Cheshire.
Wilson, John Grant, Esq., Surgeon, Bristol.
Wilson, J. H., Esq., Surgeon, (late of Sheffield.)
Wilson, Thomas, Esq., Surgeon, Nottingham.
Wilson, William Murray, Esq., Surgeon, Horsforth, near Leeds.
Wilson, W. J., Esq., Surgeon to the Royal Infirmary, Manchester.
Wilton, J. W., Esq., Surgeon to the Infirmary, Gloucester.
Windsor, John, Esq., F.L.S., Surgeon to the Eye Hospital, Manchester.
Wing, H., Esq., Surgeon, Bury St. Edmunds, Suffolk.
Winter, T. B., Esq., Surgeon, Brighton, Sussex.
Winzar, John, Esq., Surgeon, Salisbury.
Wisemann, W. W., Esq., Surgeon, Ossett, near Wakefield, Yorkshire.
Wolfenden, James Mills, M.D., 30, Hunter Street, Brunswick Square, London.
Wolstenholme, George, Esq., Surgeon, Bolton, Lancashire.

Wood, Abraham, Esq., F.R.C.S., Rochdale, Lancashire.
Wood, Charles Walker, Esq., Surgeon, Woodhouse Eaves, near Mountsorrel, Leicestershire.
Wood, Hugh, Esq., Surgeon, Sheffield, Yorkshire.
Wood, Miles Astman, Esq., Surgeon to the Dispensary, Ledbury, Herefordshire.
Wood, Peter, M.D., Physician to the Royal Infirmary, Dispensary, Fever Wards, and Lunatic Asylum, Manchester.
Wood, Robert, Esq , Surgeon, Ashton-under-Lyme, Lancashire.
Wood, R. H., Esq., Surgeon, Prus, Salop.
Wood, William, M.D., (Edin.,) M.R.C.S., (late of Newport, Salop.)
Woodforde, Francis Henry, M.D., (Edin.,) M.R.C.S., Physician to the Taunton and Somerset Hospital, Taunton.
Woodhouse, Richard, M.D., Reading, Berks.
Woodman, James, M.D., Chichester.
Woods, Charles John, Esq., Surgeon, Godmanchester, Huntingdonshire.
Woods, Francis, Esq., Surgeon, Northampton.
Woodward, William, Esq., Surgeon, Honiton, Devon.
Woodyatt, John, Esq., Surgeon, Wisteston Court, Hereford.
Wooldridge, Henry, Esq., Surgeon, Botley, Hants.
Workman, Thomas, Esq., Surgeon, Guernsey.
Workman, Thomas Keate, Esq., Surgeon, Reading, Berks.
Worship, J. Lucas, Esq., Surgeon, Riverhead, Sevenoaks, Kent.
Worthington, W., Esq., Senior Surgeon to the Infirmary, Lowestoft, Suffolk.
Wraith, Hope Samuel, Esq., Surgeon, Over Darwin, Lancashire.
Wreford, Samuel, Esq., Surgeon, Ottery-St. Mary, Devon.
Wright, Edward W., M.D., Shipston-on-Stour, Worcestershire.
Wright, Francis, M.D., Market-Harborough, Leicestershire.
Wright, Henry, Esq., Surgeon, March, Cambridgeshire.
Wright, John, Esq., F.R.C.S., Surgeon to the General Infirmary, Derby.
Wyman, George, Esq., Surgeon, Alcester, Warwickshire.
Wyman, W. S., Esq., Surgeon, Kettering, Northamptonshire.

Y.

Yate, Frederick, Esq., Surgeon, Godalming, Surrey.
Yonge, James, M.D., Fellow of the Royal College of Physicians, Plymouth, Devon.
Yonge, John Francis Dale, M.D., Coblentz, Germany.
Young, Edward William, Esq., Surgeon, Henley-upon-Thames, Oxfordshire.
Young, F. A., Esq., Surgeon, Hawkehurst, Kent.
Young, James, Esq., Surgeon, Wells, Norfolk.

NAMES OF MEMBERS RECEIVED TOO LATE TO BE INSERTED IN THEIR PROPER PLACES, OMISSIONS, AND CORRECTIONS.

Bignell, John Beavis, M.D., Physician to the Dispensary, Barnstaple.

Cowdell, Charles, M.B., Physician to the Dorset County Hospital, Dorchester, instead of Oundle, Northamptonshire.

Cream, George, Esq., Surgeon, Long Melford, Suffolk.

Holbrook, James, M.D., Andover Villa, Cheltenham, instead of Holbrook, James, M.D., Oystermouth, near Swansea, Glamorganshire.

Needham, W. W., Esq., Surgeon, Atcham, Salop, deceased.

ERRATUM.

At page 213, 5th line from the bottom, there is an error in the punctuation. Instead of "Twenty minims were given, and twice ten in a quarter of an hour. The child, a small one, was born," &c., *read*—"Twenty minims were given, and twice, ten. In a quarter of an hour the child, a small one, was born," &c.

As it is scarcely possible to avoid errors in printing so numerous a list of Members, the Secretary is anxious, wherever they are committed, that they may be amended; and will therefore feel obliged if those Members whose designation and address are not rightly inserted, or whose christian names are omitted, will send the requisite corrections.

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TO WHICH THE ATTENTION OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION

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1st.—Collection of useful information, whether speculative or practical, through Original Essays, or Reports of Provincial Hospitals, Infirmaries, or Dispensaries, or of private practice.

2nd.—Increase of knowledge of the Medical Topography of England, through statistical, meteorological, geological, and botanical inquiries.

3rd.—Investigations of the modifications of Endemic and Epidemic Diseases, in different situations, and at various periods, so as to trace, so far as the present imperfect state of the art will permit, their connections with peculiarities of soil or climate, or with the localities, habits, and occupations of the people.

4th.—Advancement of Medico-Legal Science, through succinct reports of whatever cases may occur in Provincial Courts of Judicature.

5th.—Maintenance of the honour and respectability of the Profession, generally, in the Provinces, by promoting friendly intercourse and free communication of its Members, and by establishing among them the harmony and good feeling which ought ever to characterize a liberal profession.

THE LAWS

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PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION.

1st.—That a Provincial Medical and Surgical Association be formed.

2nd.—That the Association be managed by a President, a President of the Council, Secretary or Secretaries, and Council.

3rd.—That the several Officers be appointed annually, by a General Meeting of Members convened for that purpose, at whichever of the principal towns may be appointed; the place of such Meeting being prospectively notified each year.

4th.—That at this Meeting shall be presented a Report, prepared by the Secretary or Secretaries, of the general state of the Association, its proceedings, and pecuniary accounts; the Report to be afterwards printed, and a copy supplied to every Member.

5th.—That at this Meeting one of the Members shall be appointed to give, at the next Annual Meeting, an account of the state or progress of Medical Science during the last year; or an Oration on some subject connected with Medical Science; or a Biographical Memoir of some eminent cultivator of Medical Science, who may have resided in the Provinces.

PRESIDENT OF THE ASSOCIATION.

6th.—That the office of President be honorary, and conferred on some senior Physician or Surgeon of eminence, resident in any of the provincial towns comprised in the circle of the Association.

OFFICERS AND COUNCIL.

7th.—That the Secretary or Secretaries be resident in Worcester, the place of publication, the duties being to attend to the printing of the *Transactions*, and to correct the press; to be present at the meeetings of the Council, and to keep the minutes thereof; to correspond with the Members of the Association; and to receive and submit to the Council all papers transmitted for publication.

8th.—That the Council consist of a President and —— Members, to be selected from the principal provincial towns. The Council, with whom must rest the chief responsibility of publication, to have full power of deciding on all papers transmitted; and the consent of three of its Members must be obtained before any paper can be published. It shall also be the duty of the Council to receive the subscriptions, when due, in their respective districts.

9th.—That the President of the Council be also the Treasurer of the Association, and keep the financial accounts.

REGULATIONS OF THE DISTRICT BRANCHES.

10th.—That Members of the Association be at liberty to form District Branches wherever it may suit their convenience.

11th.—That in order to facilitate the formation of such Branches, and maintain uniformity amongst them, the General Council provide suitable instructions for the guidance of those who may unite in instituting them.

12th.—That conformity with these instructions be further ensured by the initiating proceedings and organization of each Branch being submitted to the General Council for their revision and approval.

13th.—That the District Branches be free to govern themselves as their respective Members may think fit; but that the by-laws ordaining the special government be submitted to the General Council previously to their taking effect, in order to guard against the possibility of any such by-laws contravening the fundamental laws of the Association.

14th.—That the District Branches be empowered to present for Election such of their Members as it may be deemed advantageous to the general and local interests of the Association to place on the General Council.

15th.—That the expenses incurred by the District Secretaries in conducting the proceedings of the District Branches be defrayed from the general fund, provided such expenses do not, in any instance, exceed one-seventh part of the guinea subscribed by each Member enrolled in the District Branch.

16th.—That if any circumstance arise in the formation of District Branches which calls for a larger expenditure than what is allowed by the foregoing resolution, such expenses, provided they do not exceed one-fourth of the guinea, may be allowed by a statement of the circumstances being made known to the General Council.

ELECTION OF MEMBERS, ANNUAL MEETINGS, &c.

17th.—That each Member, on applying for admission, be nominated by two Members, as a pledge of eligibility.

18th.—That at each Annual Meeting the place of meeting for the ensuiug year shall be announced.

19th.—That any Member wishing to propose a new law, or an alteration in an existing law, must send notice of his intention to the Secretary or Secretaries three months previous to the Anniversary Meeting, which will be circulated with the Report of the Council.

20th.—That the Association appoint Honorary Members at the Anniversary Meetings only.

21st.—That the Association appoint Members in foreign countries, to be styled "Honorary Corresponding Members," from whom communications, respecting the state of medicine in those countries, are expected to be received.

22nd.—That if a Member be accused of professional impropriety, or misconduct, and a majority of those present upon the Annual or a Special General Meeting consider the charge to be proved, the name of such Member shall be removed from the list; but no

measure of this kind shall be adopted without the accused having two months' notice of the charge to be brought against him, and of the parties by whom he has been accused, that he may, if he so please, explain or defend his conduct.

BENEVOLENT FUND.

23rd.—That a Medical Benevolent Society, under the restrictions proposed in the Report of the Committee presented to the Anniversary Meeting at Oxford, be connected with the Association.

PAYMENT OF SUBSCRIPTIONS, &c.

24th.—Each Member of the Association to pay one guinea admission, and the same amount annually afterwards; the subscription to commence from the 1st of January each year, and to be considered as due, unless notice of its being withdrawn be given to the Secretary or Secretaries antecedently to the year for which it would be payable; for such subscription each Member shall receive a copy of each and all publications issued for the general use of the Members of the Association; but if any Member's subscription remain unpaid twelvemonths after it shall have become due, the Medical Journal and other publications of the Society shall be withheld from such Member till his arrears be paid.

25th.—That those Members who have not an opportunity of paying their subscriptions to a Member of the Council resident in their district, are requested to pay it through the medium of their own bankers, to Messrs. Robarts and Co., London, for Messrs. Berwick and Co., Worcester, to the credit of the Association, or by a Post-office order, sent to the President of the Council or the Secretary, which mode of remittance is specially pointed out, from being found the most convenient in conducting the business of the Society.

26th.—That all Papers and other communications be addressed to the Secretary or Secretaries, at Worcester, and forwarded carriage free.

27th.—That Messrs. Berwick and Co., Old Bank, Worcester, be the Bankers of the Association.

JAMES P. SHEPPARD,
SECRETARY, PRO. TEM.

RULES OF THE BENEVOLENT FUND

OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION.

Before specifying the Rules which are to direct the proceedings of this department of the Association, it is proper to repeat, in this place, the main principles on which it is established. It is not intended either to be a Benefit Society, or an Assurance Club; but, strictly speaking, a benevolent or charitable institution, founded and promoted for the express purpose of assisting our professional brethren, when struggling under the pressure of disease or other calamities. It is likewise proposed, under circumstances of peculiar urgency and distress, to administer relief to the widow or family of a professional man, who may have been deprived of the support and protection of a husband or parent. While, therefore, the sole design of this Society is to hold out the hand of charity and benevolence to a suffering and afflicted brother, or his family, it will not countenance improvidence or idleness, or evil habits of any kind.

The principle above stated has received the sanction of three successive meetings of the "Provincial Medical and Surgical Association;" and the following resolutions were finally adopted at the Anniversary held at Manchester, on the 20th and 21st of July, 1836:—

1st. That a charitable fund be created by donations and subscriptions of members of the Association, to be called "The Benevolent Fund of the Provincial Medical and Surgical Association."

2nd. That contributions be received from all persons friendly to the objects of the Society, though belonging neither to the Association nor to the profession.

3rd. That the object of the fund be the relief of medical men* under severe and urgent distress, occasioned by sickness, accident, or any other calamity.

4th. That any medical man labouring under such afflictions be considered a fit object for the charity.

5th. That the claims of contributors shall, as far as possible, have the preference; but that contributions to the fund give no claim of right to relief, the fund being one of pure charity, and that each case be judged according to the urgency of the distress.

6th. That under circumstances of peculiar emergency, relief may be extended to the widows and orphans of medical men, it being understood that it is not the design of this fund to relieve medical men from the necessity of providing for their families by ordinary life insurances, and such other means as prudence dictates.

7th. That the management of the fund be conducted by Committees of the contributing members, annually appointed; the Central Committee to be at Cheltenham, and Local Committees, subordinate to the Central, in each of the principal cities and towns—the Central Committee having power to appoint Local Committees wherever they may be required.

All communications to the Central Committee to be addressed to the Treasurer and Secretary, William Newnham, Esq., Farnham, Surrey.

* The Society will not acknowledge any one as a fit object of relief who has not received a regular professional education, and is not either a Doctor of Physic, or a Member of the College of Surgeons, or of the Apothecaries' Company.

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17th.—That each Member, on applying for admission, be nominated by two Members, as a pledge of eligibility.

18th.—That at each Annual Meeting the place of meeting for the ensuiug year shall be announced.

19th.—That any Member wishing to propose a new law, or an alteration in an existing law, must send notice of his intention to the Secretary or Secretaries three months previous to the Anniversary Meeting, which will be circulated with the Report of the Council.

20th.—That the Association appoint Honorary Members at the Anniversary Meetings only.

21st.—That the Association appoint Members in foreign countries, to be styled "Honorary Corresponding Members," from whom communications, respecting the state of medicine in those countries, are expected to be received.

22nd.—That if a Member be accused of professional impropriety, or misconduct, and a majority of those present upon the Annual or a Special General Meeting consider the charge to be proved, the name of such Member shall be removed from the list; but no

measure of this kind shall be adopted without the accused having two months' notice of the charge to be brought against him, and of the parties by whom he has been accused, that he may, if he so please, explain or defend his conduct.

BENEVOLENT FUND.

23rd.—That a Medical Benevolent Society, under the restrictions proposed in the Report of the Committee presented to the Anniversary Meeting at Oxford, be connected with the Association.

PAYMENT OF SUBSCRIPTIONS, &c.

24th.—Each Member of the Association to pay one guinea admission, and the same amount annually afterwards; the subscription to commence from the 1st of January each year, and to be considered as due, unless notice of its being withdrawn be given to the Secretary or Secretaries antecedently to the year for which it would be payable; for such subscription each Member shall receive a copy of each and all publications issued for the general use of the Members of the Association; but if any Member's subscription remain unpaid twelvemonths after it shall have become due, the Medical Journal and other publications of the Society shall be withheld from such Member till his arrears be paid.

25th.—That those Members who have not an opportunity of paying their subscriptions to a Member of the Council resident in their district, are requested to pay it through the medium of their own bankers, to Messrs. Robarts and Co., London, for Messrs. Berwick and Co., Worcester, to the credit of the Association, or by a post-office Order, sent to the President of the Council or the Secretary, which mode of remittance is specially pointed out, from being found the most convenient in conducting the business of the Society.

26th.—That all Papers and other communications be addressed to the Secretary or Secretaries, at Worcester, and forwarded carriage free.

27th.—That Messrs. Berwick and Co., Old Bank, Worcester, be the Bankers of the Association.

ROBERT J. N. STREETEN,
SECRETARY.

RULES OF THE BENEVOLENT FUND

OF THE

PROVINCIAL MEDICAL AND SURGICAL ASSOCIATION.

Before specifying the Rules which are to direct the proceedings of this department of the Association, it is proper to repeat, in this place, the main principles on which it is established. It is not intended either to be a Benefit Society, or an Assurance Club; but, strictly speaking, a benevolent or charitable institution, founded and promoted for the express purpose of assisting our professional brethren, when struggling under the pressure of disease or other calamities. It is likewise proposed, under circumstances of peculiar urgency and distress, to administer relief to the widow or family of a professional man, who may have been deprived of the support and protection of a husband or parent. While, therefore, the sole design of this Society is to hold out the hand of charity and benevolence to a suffering and afflicted brother, or his family, it will not countenance improvidence or idleness, or evil habits of any kind.

The principle above stated has received the sanction of three successive meetings of the "Provincial Medical and Surgical Association;" and the following resolutions were finally adopted at the Anniversary held at Manchester, on the 20th and 21st of July, 1836:—

1. That a charitable fund be created by donations and subscriptions of members of the Association, to be called "The Benevolent Fund of the Provincial Medical and Surgical Association."

2. That contributions be received from all persons friendly to the objects of the Society, though belonging neither to the Association nor to the profession.

3. That the object of the fund be the relief of medical men* under severe and urgent distress, occasioned by sickness, accident, or any other calamity.

4. That any medical man labouring under such afflictions be considered a fit object for the charity.

5. That the claims of contributors shall, as far as possible, have the preference; but that contributions to the fund give no claim of right to relief, the fund being one of pure charity, and that each case be judged according to the urgency of the distress.

6. That under circumstances of peculiar emergency, relief may be extended to the widows and orphans of medical men, it being understood that it is not the design of this fund to relieve medical men from the necessity of providing for their families by ordinary life insurances, and such other means as prudence dictates.

7. That the management of the fund be conducted by Committees of the contributing members, annually appointed; the Central Committee to be at Cheltenham, and Local Committees, subordinate to the Central, in each of the principal cities and towns—the Central Committee having power to appoint Local Committees wherever they may be required.

All communications to the Central Committee to be addressed to the Treasurer and Secretary, William Newnham, Esq., Farnham, Surrey.

* The Society will not acknowledge any one as a fit object of relief who has not received a regular professional education, and is not either a Doctor of Physic, or a Member of the College of Surgeons, or of the Apothecaries' Company.